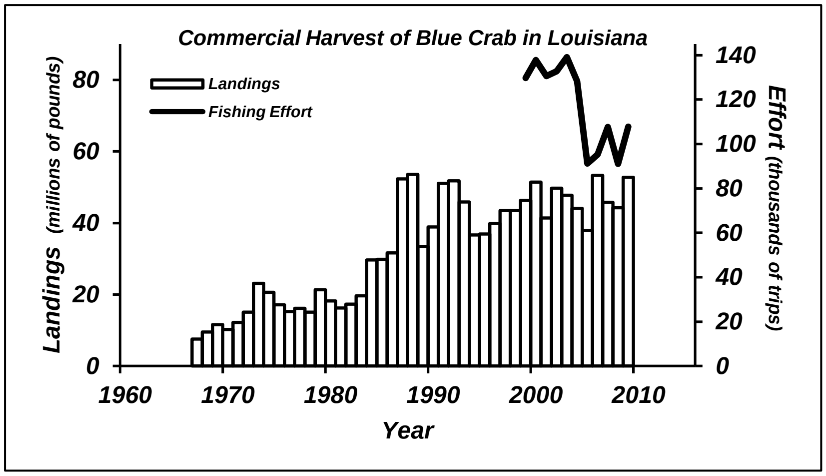
Assessment of Blue Crab *Callinectes sapidus* in Louisiana Waters
2011 Report

Executive Summary

- Commercial landings of blue crab in Louisiana have remained above 40 million pounds per year since 1997 with the exception of 2005. The passages of Hurricanes Katrina and Rita caused substantial reduction in the directed effort of the commercial fleet when compared to previous years. This decline is attributed to the devastation of infrastructure, vessels, and fishing gear caused by hurricane passage. Given this reduction in effort, landings remained high indicating higher fisher success rates and abundance of blue crabs. The highest reported landings in the time-series were 53.5 and 53.3 million pounds harvested in 1988 and 2006, respectively.



- The inception of the Louisiana Department of Wildlife and Fisheries Trip ticket Program, in 1999, significantly increased the ability of resource managers to monitor trends in catch rates of Louisiana's commercial fisheries resources. Landings records pre-1999 are taken from National Marine Fisheries Service statistical records, which lack effort data, precluding estimates of fishery-dependent catch rates for the entire time-series.

- This assessment is based on a Collie and Sissenwine or catch-survey analysis and results in estimates of exploitable biomass and recruitment of the Louisiana blue crab stock, 1968-2009. Fishing mortality is estimated, but not available for the last year of the time-series. This assessment model has been extensively used in crustacean stock assessments. Data requirements include a time series of observed landings and corresponding abundance indices for recruits and exploitable life stages. Indices of abundance are derived from the Louisiana Department of Wildlife and Fisheries fishery-independent trawl survey. Landings are taken from National Marine Fisheries Service statistical records, 1968-1998, and the Louisiana Department of Wildlife and Fisheries Trip Ticket Program, 1999-2009.

- There are currently no conservation standards for the Louisiana blue crab stock. Current management of the fishery includes a minimum size limit in addition to gear restrictions. Based on results of this assessment, targets and explicit limits of fishing are proposed as conservation standards to ensure future sustainability of the Louisiana blue crab stock.

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1. Introduction

A catch-survey or Collie and Sissenwine analysis is applied to the Louisiana (LA) blue crab *Callinectes sapidus* stock (Collie and Sissenwine, 1983). This model balances the number of individuals from one life stage to the next (i.e., recruits to exploitable sizes) given constant natural mortality, while scaling these values to harvest. Data requirements are moderate: a time series of observed landings and corresponding abundance indices for the recruit and fully-recruited life stages. Indices of abundance are derived from the Louisiana Department of Wildlife and Fisheries (LDWF) fishery-independent trawl survey, 1967-2009. Landings are taken from National Marine Fisheries Service (NMFS) statistical records, 1968-1998, and the LDWF Trip Ticket Program, 1999-2009 (Table 1, Figure 1).

1.1 Unit Stock Definition

Adult blue crabs in the northern Gulf of Mexico (GOM) generally remain within one estuary for life. Females, however, migrate to higher salinity nearshore waters to spawn, where larvae are then dispersed offshore via tidal transport (Guillory et al. 2001). Recruitment and settlement of larvae into northern GOM estuaries (as megalopae) is likely influenced by wind and tidal circulation processes (Perry et al. 1995). Stock mixing between estuaries (and states) is very probable given these larval transport mechanisms. Nonetheless, blue crab landings from the northern Gulf of Mexico (GOM) are primarily of Louisiana origin (Table 2).

For purposes of this assessment the blue crab unit stock is defined as those crabs occurring in LA waters. This is consistent with a non-regional or statewide management strategy. Population assessment at a regional or basin-specific level could be difficult without substantial, and expensive, increases in fishery dependent and independent sampling effort.

1.2 Status of the Fishery

A comprehensive history of the blue crab resource and its fishery in Louisiana (LA) is described by Guillory et al. (1996) and for the northern GOM by Guillory et al. (2001).

Louisiana blue crabs have been commercial exploited since the 1800s with the earliest documented landings reported in 1880. Little documentation exists describing recreational blue crab landings and activities. A survey of the recreational blue crab fishery in Terrebonne Parish, LA (Guillory 1999b) suggests a relatively small portion of the overall landings are taken from the recreational sector (i.e., approximately 5%).

Prior to 1940, soft crab annual landings averaged approximately 192,000 pounds, where harvest was primarily from haul seines, bush traps, dip nets, trotlines and drop nets. During the 1960s and through the early 1980s soft crab landings steadily declined to 75,000 pounds. This decline has been attributed to unreliable sources of peeler crabs and declining estuarine water quality (Jaworski 1971, 1972, 1982; Perry et al. 1984). By 1990, soft crab production increased to approximately 250,000 pounds due to increased adoption of advanced shedding systems and increased awareness of the value of peeler crabs (Guillory et al. 1996). Reported annual harvest of peeler and soft crab production declined through the 1990s and averaged 169,500 pounds. Following introduction of the LDWF Trip Ticket reporting program in 1999, landings of peeler and soft crabs have become more distinguishable from hard crab landings due to increased refinements in reporting. From 1999 through 2009, peeler and soft crab landings averaged approximately 259,300 pounds and 39,900 pounds, respectively. Even though the soft / peeler harvest is a very minor portion of the total blue crab landings, the added value of that harvest is demonstrated in the percent contribution of that harvest to the total values (Table 1).

Prior to 1969, commercial hard crab landings averaged 7.7 million pounds annually and were primarily harvested with trawls, baited trotlines, handlines, hoop nets and drop nets (Guillory et al. 1996). With the introduction of the wire crab trap, landings began to increase through the 1980s. From 1979 to 1989 the number of commercial trap licenses issued by the LDWF increased approximately 300% from 751 to 3019 trap licenses per year. Following 1983, dramatic increases in effort led to record landings, with 53.5 million pounds harvested in 1988 (Table 1). These increases likely resulted from a combination of factors including resource abundance, low fixed investment costs, an economic downturn in the oil and gas industry leading to increased fishery participation, economic overfishing and resource reductions in other fisheries, and a sudden influx of Indochinese refugees into the fishery (Roberts and Thompson 1982; Keithly et al. 1988; Steele and Perry 1990). Landings in 1991 and 1992 exceeded 50 million pounds and averaged 43.4 million pounds through the 1990s. Since 2000, landings have averaged 46.5 million pounds annually; however, impacts associated with Hurricanes Katrina and Rita in 2005 and Hurricanes Gustav and Ike in 2008 led to substantial decreases in the directed effort of the commercial fleet. Hurricane impacts included significant loss and disruption of infrastructure supporting the fishery and widespread gear losses. In recent years, the majority of hard blue crab landings have come from crab traps, while handlines, trawls and skimmer gear have provided only minor contributions to the total (Table 3).

The blue crab fishery operates the entire year, but typically has the highest landings from May through August, and the lowest landings in February and March (Table 4). Harvest occurs statewide across the coast, with the Pontchartrain and Terrebonne basins providing the highest portion of the landings, followed closely by Barataria and Atchafalaya/Teche/Vermilion. The Mississippi Delta, Calcasieu, and Mermentau provide smaller contributions, and the Sabine basin provides a very minor portion (Table 5). Those small portions are understandable, given the relatively small areal extent of these systems.

1.3 Regulations

The Louisiana blue crab fishery and its industry is governed by the State of Louisiana legislative, the Department of Wildlife and Fisheries and the Wildlife and Fisheries Commission. The Louisiana commercial blue crab fishery is currently regulated with a minimum size limit (i.e., a minimum carapace width of 5 inches) in addition to gear restrictions. Recreationally caught blue crabs are not subject to a minimum size limit. No bag and possession limits exist for the recreational and commercial fisheries. A more detailed summary of regulations for the Louisiana blue crab fishery is presented (see *Appendix-Regulation Summary).*

1.4 Trends in Harvest

Much of the early history of the Louisiana blue crab fishery is poorly documented with commercial landings first reported in 1880 (Perry et al. 1984). The early commercial fishery was centered near New Orleans and supplied the French Market and local restaurants. New Orleans later became a major seafood supplier with links to large cities along the Gulf coast.

Guillory et al. (1996) provide a description of the Louisiana blue crab fishery detailing the history of exploitation, description of fishing activities, trends in effort and harvest, and economics within the fishery. Guillory et al. (2001) describe in detail the northern GOM blue crab fishery by state.

Prior to 1969, commercial blue crab landings averaged approximately 7.7 million pounds annually. With the introduction of the wire crab trap, landings increased gradually from the late 1960s through the early 1980s reaching an all time record of 53.5 million pounds in 1988 (Table 1). Despite several relatively poor production years and increases in fishing effort in the late 1980s, landings during the 1990s averaged approximately 43.2 million pounds. Landings during this period were approximately 3.5 million pounds above the 15-year average although declines in catch per unit effort (CPUE) by fisher and by trap were observed. The number of licensed crab trap fishermen increased from 1,994 in 1986 to 3,557 in 1999. Annual crab trap license sales averaged 2,744 from 1990 to 1995 and increased to 3,519 in 1996 (largely in response to speculation associated with a two-year license moratorium). Following 2000, annual license sales have stabilized averaging 3,293 per year. It is important to mention that not all crab trap license holders are active in the fishery. Although annual crab trap license sales averaged 3,293 following 2000, the number of fishermen reporting LDWF trip ticket sales of crabs averaged 1,641 or approximately 50% of those holding licenses during this same period. This disparity is attributed to: 1) continued speculation over the potential for a renewed license moratorium, 2) recreational fishers obtaining a commercial gear license to fish more traps than the recreational limit, 3) non-compliance with trip ticket reporting requirements, and 4) perceptions of reduced criminal liability by some shrimp fishermen who may temporarily possess traps through shrimp fishing gear interactions.

Guillory et al. (2001) reported that the total number of traps in Louisiana ranged from 75,760 in 1970 to 139,044 in 1983. The authors also reported the average number of traps per fisher increased from 25 in 1957 to 228 in 1987 and declined to between 129 and 163 traps per fisher in the 1990s.

Crab traps remain the dominant gear type used in the fishery accounting for over 99.5% of commercial landings since 1999 with trawls and skimmer nets accounting for the remaining landings (Table 3). Monthly hard crab landings peak from late spring through summer (May-August) with secondary peaks typically occurring in October and November. Landings decline through winter with February and March accounting for the lowest monthly landings of the year.

Although year to year fluctuations occur, the Pontchartrain Basin contributed approximately 31% to the total Louisiana blue crab landings in 2009 and has consistently lead all Louisiana basins in blue crab landings since 2005. In order of percent contribution, the Terrebonne Basin followed with 26% of the 2009 total with the Barataria Basin (18%), Atchafalaya/Vermilion/Teche River Basin (14%), Mississippi River Basin (2%), Calcasieu River Basin (6%), Mermentau River Basin (3%) and Sabine River Basin (<1%) accounting for the remainder (Table 5).

In a two-year crab effort survey, the LDWF conducted a total of 211 crab fisher and 28 crab dealer interviews to develop information on number of traps used, number of traps run, soak times, bait types and trip times. Crab fishers from the Vermilion/Teche River Basins reported the highest number of baited traps per fisher (513) during the two-year survey period followed by those in the Mississippi River Basin (438), Atchafalaya River Basin (400), Barataria Basin (282), Pontchartrain Basin (274), Terrebonne Basin (205) and Calcasieu River Basin (203). The average number of crab traps run per fisher ranged from 337 in the Vermilion/Teche River Basin to 171 in the Terrebonne Basin. Average trap soak times ranged from a maximum of 112 hours in the Atchafalaya River Basin to a minimum of 30 hours in the Terrebonne Basin. Ranked by number of trips taken (rather than pounds used), the most prominent bait type used by trap fishermen was menhaden (*Brevoortia patronus*) followed by unclassified catfish, striped mullet (*Mugil cephalus*), unclassified shad and the carcasses of spotted seatrout (*Cynoscion nebulosus*). Average trip time for crab fishers ranged from 6-24 hours with Terrebonne Basin fishers averaging the longest trips in both survey years.

Based on the number of licensed fishers reporting LDWF trip ticket sales of blue crabs, the average annual catch per trip since 1999 has ranged from 316 pounds reported in 2001 to 560 pounds in 2006 (the year following Hurricanes Katrina and Rita). Annual catch per trip from 1999 through 2004 averaged 352 pounds and has recently increased to an average of 461 pounds, 2005-2009. The average number of trips (per trap fisher) has declined from levels seen in the early 2000s (Figure 1). Harvest per trip has varied over the same time period, 1999-2009 (Figure 2).

2. Life History Information

Guillory et al. (1996) summarized literature and data on the biology and ecology of blue crabs in a source document for the management of the Louisiana blue crab fishery. In addition to describing the fishery and commenting on research needs, the authors described blue crab taxonomy and nomenclature; larval, juvenile and adult morphology; distribution and abundance; habitat utilization; reproduction; age and growth; trophic relationships; behavior; movement and migration; pathology and parisitology; environmental tolerances; recruitment mechanisms; and mortality.

In “The Blue Crab Fishery of the Gulf of Mexico, United States: A Regional Management Plan”, Guillory et al. (2001) developed a broad and comprehensive document addressing all relevant aspects of blue crab biology and the fishery. In addition to describing stock habitat, fishery management jurisdiction, economic and sociocultural characteristics of the fishery, management considerations/recommendations, and research needs, the authors provided detailed information on blue crab life history, including: geographic distribution; classification, morphology and genetic characterization; age, growth and maturation; reproduction; stock-recruitment relationship; larval development, distribution and abundance; megalopal settlement and recruitment; juvenile development, distribution and abundance; seasonal and areal distribution; factors influencing survival; parasites and diseases; food habits; predator/prey relationships; interspecific and intraspecific predation; foraging behavior; larval, juvenile and adult behavior; autonomy; and movements/migrations.

2.1 Maturity

Carapace width (CW) at maturity is reported by Guillory and Hein (1997a) for blue crabs from the Terrebonne Basin, LA. Males and females reached 50% sexual maturity at $110mm$ and $125mm$ CW, respectively. The CW-at-50% sexual maturity for female crabs corresponds with the minimum size limit of the LA commercial blue crab fishery (i.e., $127mm$ CW). Males and females reached 100% sexual maturity at $130mm$ and $160mm$ CW, respectively.

2.2 Growth

Blue crabs exhibit a discontinuous growth pattern; where growth occurs during the molting process (Guillory et al., 2001). Continuous growth models, however, are used to describe blue crab growth (Helser and Kahn, 2001; Pellegrin et al., 2001; Rugolo et al., 1998; Smith, 1997). Previous model based estimates for the Gulf of Mexico (GOM) have relied on the von Bertalanffy (Pellegrin et al., 2001; Smith, 1997). Because most GOM blue crabs reach maturity and recruit to the fishery within one year (Guillory et al., 2001), the three parameter von Bertalanffy model provides poor fits to reported CW-at-age data . Zweifel and Lasker (1976) suggest the generalized von Bertalanffy, Logistic, or Gompertz models as preferred descriptors of growth when an inflection point is evident in the trajectory.

The Gompertz model (Winsor, 1932) is used to describe LA blue crab growth for this assessment. The model is configured as:

$$CW_t = CW_\infty e^{\alpha(e^{\beta t})} \quad [1]$$

where CW_t is CW-at-age, CW_∞ is the asymptotic average maximum CW, and α and β are constant growth coefficients. The model was fit by minimizing the sum of squared residuals of observed and predicted size-at-ages. The α and β parameters lack relevant biological interpretation (Beverton and Holt, 1957). Nonetheless, Gompertz models provide obvious better fits to reported blue crab CW-at-age data then the three parameter von Bertalanffy function (Figures 3, 4, 5).

Blue crabs lack calcified hard parts, which make growth estimation difficult. Seasonal CW-at-age data from April, July, and October hatches are taken from crabs reared in St. Johns River, Florida (Tagatz, 1968) (Table 6). Crabs reared in captivity may not accurately represent the growth rates of crabs in their natural habitat (Pellegrin et al., 2001). These estimates, however, are currently the best available for the northern GOM.

Based on evidence that female crabs undergo a terminal molt at sexual maturity (Van Engel, 1958), the average size of female crabs $\geq 160mm$ captured from the trawl survey is used as a proxy for average maximum CW (Table 6). This CW corresponds with 100% sexual maturity (Guillory and Hein, 1997b) and is coupled with an assumed maximum age of 3 years to provide an additional data pair for model fitting (Table 6).

Monthly hatches, or the time when CW=0, are approximated by using mid-points of each month (e.g., for April $\frac{4-0.5}{12}$). Resulting growth trajectories are used as seasonal growth indices: April's trajectory as the January-April index; July's trajectory as the May-August index; and October's trajectory as the September-December index (Figure 6).

A monthly size-at-capture matrix is developed from these seasonal growth indices (Table 7). This matrix represents CW-at-capture of monthly cohorts and allows for the identification of crabs from the trawl survey that would not recruit to the fishery during the survey year (i.e., by December 31st). This implies variation in CW-at-age as primarily due to time of hatching. Carapace widths of crabs not fully-recruited to the trawl gear (i.e., $< 25mm$ CW) are excluded. Rows represent monthly cohorts (or seasonal growth trajectories), with the current year-class above the diagonal and the previous year-class below the diagonal. Columns represent months of the LDWF fishery independent trawl survey. As an example, blue crabs captured by the trawl survey in August that are $\leq 63mm$ CW (or the current year's March-August cohorts) are considered pre-recruits. An obvious discrepancy exists for the survey month of June, where the previous years' December cohort is approximately the same size as the current years' March cohort. To account for this, pre-recruits are only identified from July-December captures.

2.3 Condition

Carapace width-weight regressions were developed by Guillory and Hein (1997a) for blue crabs from the Terrebonne Basin, LA. For the purpose of this assessment, only the pooled (or non-sex specific) model is used. Blue crab weight at CW is calculated from:

$$W = 8.26 \times 10^{-4} CW^{2.446} \quad [2]$$

where W is weight in grams and CW is carapace width in mm.

2.4 Natural Mortality

Due to the difficulty of directly estimating instantaneous natural mortality (M) of blue crab (Vetter, 1987; Hewitt et al., 2007), M is estimated based on assumptions of maximum age. Reported maximum age of blue crab along the Atlantic Coast range from $3 - 6\ years$ (Kahn and Helser, 2005; Miller et al., 2005; Murphy et al. 2007). There are no longevity estimates for blue crab in the GOM (Guillory et al., 2001). Instantaneous natural mortality is estimated as $M = 1.0$, based on the International Council for the Exploration of the Seas (ICES) convention $M = 3/maximum\ age$, where longevity is assumed as 3 $years$. This longevity assumption and subsequent M estimate are consistent with other blue crab stock assessments (Kahn and Helser, 2005; Murphy et al. 2007).

3. Data Sources

3.1 Fishery Dependent

Louisiana blue crab commercial harvest is derived from NMFS statistical records, 1968-1998, and the LDWF Trip Ticket program, 1999-2009 (Table 1). A time-series of recreational harvest records currently does not exist. Guillory (1999b) estimates the recreational harvest rate as 4.1% of the reported commercial harvest in a survey of the recreational blue crab fishery in Terrebonne Parish, LA.

3.2 Fishery Independent

Blue crab abundance indices are derived from the LDWF fishery-independent trawl survey, 1967-2009. This survey uses a standardized design and is conducted throughout the year at fixed sampling locations. Sampling gear is a 4.9m flat otter trawl with a body and cod-end consisting of 19mm and 6.4mm bar meshes, respectively. Samples are 10 minute tows. All captured crabs are enumerated and a maximum of 50 randomly selected crabs per sample are measured (in $5mm$ CW bins). When more than 50 crabs are captured, catch-at-size is derived as the product of total catch and proportional subsample-at-size.

Abundance indices are developed from the LDWF fishery independent trawl survey for life stages relative to the fishery. These include: 1) fully-recruited or legal crabs (i.e., $\geq 125mm$ CW), 2) recruits or crabs that will recruit to the fishery during the survey year (i.e., by December 31st), and 3) pre-recruits or crabs that will not recruit to the fishery during the survey year (Tables 8, 9, 10). Due to size selectivity of the survey gear, crabs $< 25mm$ CW are excluded from index development. Crabs that will not recruit to the fishery during the survey year are identified by the size-at-capture matrix (Table 7, Figure 7).

Mean catch per tow and its variance are calculated by assuming a delta-lognormal or Δ-distribution. This method is appropriate for lognormally distributed survey datasets when a proportion of zero catches occur (Pennington, 1983; Pennington, 1996). Delta-lognormal means are the product of the proportion of positive catches (assuming a binomial error structure) and the geometric mean catch-per-unit effort of successful trips (assuming a lognormal error structure). Its variance is approximated as:

$$Var(XY) \approx \mu_Y^2\sigma_X^2 + \mu_X^2\sigma_Y^2 + 2\mu_X\mu_Y\rho\sigma_X\sigma_Y \quad [3]$$

where μ_Y is the binomial mean proportion of positive catches, μ_X is the geometric mean catch-per-unit-effort of successful tows, σ_Y^2 and σ_X^2 are the respective variances, and ρ is the correlation between X and Y.

4. Assessment Model

A catch-survey (CS) or Collie and Sissenwine analysis is used to describe the dynamics of the LA blue crab stock (Collie and Sissenwine, 1983). This model (or variants of) has been extensively used in crustacean stock assessments (Conser and Idoine, 1992; Collie and Kruse, 1998; Cadrin et al., 1999; Kahn and Helser, 2005; Miller et al., 2005; Murphy et al. 2007; Zheng et al., 1997). The CS modeling approach is intended for data moderate situations where a full age structure is lacking. Model requirements include: 1) annual abundance indices for the recruit and fully-recruited life stages, 2) annual harvest estimates as individuals, 3) an estimate of instantaneous natural mortality, and 4) the relative selectivity of the recruit and fully-recruited life stages to the survey gear.

4.1 Model Configuration

The model is based on the modified Delury discrete difference equation (Collie and Sissenwine, 1983):

$$N_{y+1} = (N_y + R_y - C_y)e^{-M} \quad [4]$$

where y is the fishing and survey year (i.e., January 1st through December 31st), N_y is the abundance of fully-recruited crabs in that year, N_{y+1} is the abundance of fully-recruited crabs in the following year, R_y is the abundance of recruits, C_y is harvest as individuals, and M is the constant natural mortality rate. To approximate landings occurring throughout the year, the model equation is reconfigured as:

$$N_{y+1} = \left[\left(N_y + R_y\right)e^{-0.50M} - C_y\right]e^{-0.50M} \quad [5]$$

where recruits and fully-recruited crabs are reduced by a half year of natural mortality before the catch is removed. Remaining survivors from the fishery are then reduced by another half year of natural mortality.

Survey indices of abundance are scaled to absolute abundance as:

$$n_y = q_n N_y e^{\eta_y} \text{ and } r_y = q_r R_y e^{\delta_y} \quad [6, 7]$$

where r_y and n_y are the observed abundance indices of recruits and fully-recruited blue crabs, q_r and q_n are the respective catchabilities of the survey gear for recruits and fully-recruited crabs, and e^{δ_y} and e^{η_y} are the respective log-normally distributed observation errors for the recruit and fully-recruited abundance indices. Reconfiguring the model equation by substituting abundance indices for absolute abundance and incorporating log-normally distributed process error e^{ε_y} yields:

$$n_{y+1} = \left[\left(n_y + \frac{r_y}{s_r}\right) e^{-0.50M} - q_n C_y)\right] e^{-0.50M} e^{\varepsilon_y} \quad [8]$$

where $s_r = \frac{q_r}{q_n}$ is the relative selectivity of recruits to fully-recruited crabs in the sampling gear. Process error is the difference between n_y calculated from equations [6] and [8]. Equation [8] is solved iteratively by minimizing the following objective function:

$$L(\theta) = \lambda_\varepsilon \sum_{y=2}^{Y} \varepsilon_y^2 + \sum_{y=1}^{Y} \eta_y^2 + \lambda_\delta \sum_{y=1}^{Y-1} \delta_y^2$$
[9]

where θ is the parameter vector and λ_ε and λ_δ are user-defined weights of the process and pre-recruit observation error relative to the fully-recruited observation error. Thus, $2Y$ parameters are estimated: n_y for all years, r_y for all years except the terminal year, and q_n. Given these estimates, absolute abundances are estimated from the following:

$$R_y = \frac{\hat{r}_y}{s_r \hat{q}_n} \text{ and } N_y = \frac{\hat{n}_y}{\hat{q}_n} \quad [10, 11]$$

where $\hat{r}_y$ and $\hat{n}_y$ are the model estimated abundance indices of recruits and fully-recruited crabs, respectively, and $\hat{q}_n$ is the model estimated catchability of fully-recruited crabs to the survey gear. Recruit abundance is estimated in the terminal year by using the observed r_y.

4.2 Fishing Mortality Estimation

Annual estimates of instantaneous total mortality are derived from the following survival ratio:

$$Z_y = log_e\left[\frac{N_y + R_y}{N_{y+1}}\right] \quad [12]$$

Estimating annual instantaneous fishing mortality F_y from $Z_y - M$ would include R_y (or crabs not available to the fishery) into the fishing mortality calculation. Because harvest occurs concurrently with M in this fishery (i.e., type II fishery; Ricker, 1975) and to avoid additional bias from $F_y = Z_y - M$, we estimate F_y from the following rearrangement of Baranov's catch equation:

$$F_y = \frac{u_y Z_y}{1 - e^{-Z_y}} \quad [13]$$

where annual exploitation is estimated as:

$$u_y = \left[\frac{C_y}{(R_y + N_y)}\right] \quad [14]$$

4.3 Biomass Conversions

Annual size distributions of Louisiana blue crab landings currently do not exist. Due to this lack of fishery dependent information, annual size distributions of blue crab captured from the LDWF fishery independent trawl survey are used as proxies to describe the annual size compositions of blue crab landings (see *Research and Data Needs*).

Annual landings in biomass are converted to individuals as:

$$C_y = \sum_i (p_{Nyi}\, H_y)/W_i \quad [15]$$

where C_y is annual harvest as individuals, i are the midpoints of $5mm$ CW bins, p_{Nyi} is the proportional (sums to 1) annual catch-at-CW of legal-sized crabs from the trawl survey (Tables 11, 12, 13), H_y is annual harvest as biomass, and W_i is the average weight-at-size.

Model estimated abundance is converted to total biomass as:

$$B_y = \sum_i R_y p_{Ryi} W_i + \sum_i N_y p_{Nyi} W_i \quad [16]$$

where B_y is total annual biomass, R_y and N_y are model estimated annual abundances of recruits and fully-recruited crabs, i are the midpoints of $5mm$ CW bins, p_{Ryi} and p_{Nyi} are the proportional annual catch-at-CW of sublegal crabs $\geq 25mm$ and legal-sized crabs from the trawl survey (Tables 11, 12, 13), and W_i is the average weight-at-size.

4.4 Model Inputs / Assumptions

A mixed error structure (i.e., process + observation) is used for model fitting. If the model is optimized with observation error alone, only uncertainty in the data is recognized. To reflect both uncertainty in the population and the data more accurately, mixed error models are preferred (NRC, 1998).

Catch-survey model assumptions are: 1) the stock is closed to migration, 2) natural mortality occurs at a constant rate, and 3) all surviving recruits will grow into the fully-recruited stage within the model year.

Survey indices of abundance are assumed proportional to absolute abundance. Instantaneous natural mortality is set as $M = 1.0$. Crabs greater than $25mm$ CW are assumed equally vulnerable to the survey gear implying $s_r = 1.0$.

The CS model is scaled to harvest with admitted process error. Louisiana blue crab harvest is derived from commercial hard crab landings, which include: NMFS statistical records, 1968-1998, and the LDWF Trip Ticket Program, 1999-2009 (Table 1). Commercial hard crab landings as individuals are expanded by 5% to approximate for recreational harvest. This rate is consistent with Guillory's (1999b) survey of the recreational blue crab fishery in Terrebonne Parish, LA.

Through simulation analysis, Mesnil (2003) demonstrates how staging error (i.e., analogous to aging error in a VPA) can bias estimates of absolute abundance and recommends "carefully allocating members to either stage". Individuals that will not recruit to the fishery during the survey year are accounted for by reconfiguring r_y as the sum of the pre-recruit index in $year$ and the recruit index in $year + 1$ (Table 14). This creates an abundance index where all surviving recruits will recruit to legal-size within the survey year. If the pre-recruit index is arbitrarily excluded, the model will interpret this as mortality and the resulting estimates will be biased. A limitation of this three stage accounting technique is the unavailability of the first year of the time-series for model fitting (Table 14).

Relative weighting of the process error component ε can significantly affect estimates of $\hat{q}_n$ and resulting absolute abundances (Cadrin et al., 1999; Mesnil, 2003). Relative weights λ_ε and λ_δ are fixed as 1.0 in this assessment. Different weighting scenarios of ε are considered (see *Model Diagnostics*).

4.5 Model Outputs / Results

The CS model provides reasonable fits to the abundance indices, with no large bias in residual patterns (Figure 8, 9, 10). However, fits to the observed indices show consistent bias in recent years. The equal weighting of process error and observation error and the assumed process error structure may inadequately represent the observations and underlying dynamics of the population (see *Model Diagnostics; Research and Data Needs*).

The catchability coefficient is estimated as $\hat{q}_n = 0.0054$. Annual fully-recruited biomass estimates range from 15 to 76 million pounds (Table 15, Figure 11) and recruit abundance estimates range from 160 to 517 million individuals (Table 15, Figure 12). Fully-recruited biomass levels generally decline after 1990, where previous years estimates were rarely below 40 million pounds. Increases in exploitation during the 1990s coincide with this decline (Figure 13). Recruit abundance varies substantially (Figure 12). No relationship is observed between fully-recruited biomass and subsequent recruitment (Figure 14).

Annual instantaneous fishing mortality estimates range from 0.09-1.03, with peak exploitation in 2002 (Table 15). Trends in fishing mortality estimates, 1999-2008, are consistent with fishing effort (i.e., trap fisher trips) derived from the LDWF Trip Ticket Program (Figure 15). A significant increase in fishing mortality was observed from 1980 through 2002 ($t = 9.39,\ p < 0.001$).

4.6 Model Diagnostics

The CS models sensitivity to different weighting scenarios ($\lambda_\varepsilon = 1.0, 0.5, 0.25$) and natural mortality assumptions ($M = 0.8, 1.0, 1.2$) are tested. Process error accounts for 25% of the total variance in the base model; therefore, only down-weighting is explored for this component. Natural morality is based on assumptions of maximum age (i.e., $2.5, 3.0, 3.8$) using the ICES convention $M = 3/maximum\ age$.

Model estimates are especially sensitive to assumptions of M. The catchability coefficient $\hat{q}_n$ decreases with increasing values of M causing negative bias in abundance estimates. Conversely, as M increases, $\hat{q}_n$ decreases, positively biasing abundance estimates (Figures 16, 17). Fishing mortality estimates are negatively influenced by increasing M (Figure 18).

The CS models estimates are only weakly sensitive to down-weighting of ε. The catchability coefficient $\hat{q}_n$ decreases minimally with declining values of λ_ε ($\hat{q}_n = 0.0054, 0.0051, and$ 0.0048, respectively).

When decreasing λ_ε , the fit of the predicted indices (i.e., observation error) is emphasized causing greater dispersion in the calculated index (i.e., process error) residuals.

5. Biological Reference Points

Overfishing and overfished limits should be defined for exploitable stocks. The implication is that when biomass falls below a specified limit, there is an unacceptable risk that recruitment will be reduced to undesirable levels. Management actions are needed to avoid approaching this limit and to recover the stock if biomass falls below the limit.

5.1 Spawning Potential Ratio

An examination of Figure 19 clearly shows that there has been no observed decline in recruitment over a wide range of fully recruited biomasses. However, an option for a precautionary limit might be imposed by requiring that biomass not fall below the lowest observed levels, for example the average biomass of the three lowest years. This would be equivalent to maintaining the stock above a limit spawning potential ratio (SPR; Goodyear, 1993). The method for calculating SPR_{limit} or equivalently SSB_{limit} is presented below.

Since there are no observed declines in recruitment with decreasing biomass, it is assumed that equilibrium recruitment $\bar{R}$ (under current biomass) is the average recruitment, 1968-2009. This is the horizontal line in Figure 19. Exploitable biomass (i.e., crabs ≥125mm) is used as a measure of spawning stock biomass (SSB). When the stock is in equilibrium, equations [5, 12, and 13] can be rearranged excluding the year index into SSB/R for any given exploitation rate F as:

$$\frac{SSB}{R}|F = \sum_a p_{Na} W_a \times \frac{e^{-M} - F/Z(1-e^{-Z})e^{-0.5M}}{1-[e^{-M} - F/Z(1-e^{-Z})e^{-0.5M}]} \quad [17]$$

where a are ages in months ($a = 1\ to\ 36$), p_{Na} is the proportional equilibrium abundance of crabs $\geq 125mm$ (see below), W_a is the average weight-at-age, and M, F, Z are the instantaneous natural, fishing and total mortality rates ($years^{-1}$). Equilibrium abundance-at-age is estimated as:

$$N_a = \bar{R} S_a \quad [18]$$

where survivorship is calculated recursively from $S_a = S_{a-1} e^{-Z_a}$, $S_1 = 1$. Size-at-age, vulnerability-at-age v_a (i.e., knife-edged selection for those ages $\geq 125mm$) and resulting monthly mortality vectors (i.e., $Z_a = M/12 + F_a$ and $F_a = v_a F/12$) are derived from the non-seasonal Gompertz growth parameters (Table 6). To approximate changes in growth through the age interval, size-at-age is calculated using the midpoints of the months (i.e., $age = a - 0.5$). Equilibrium N_a of exploitable sized crabs is normalized to 1 as $p_{Na} = \frac{N_{a \geq 125mm}}{\sum_a N_{a \geq 125mm}}$.

If the biomass limit is chosen as the geometric mean of the three lowest exploitable biomasses observed, then the recruits per SSB (R/SSB_{limit}) that is equivalent to the biomass limit is the slope of the diagonal line from the origin that intersects the equilibrium recruitment $\bar{R}$ at SSB_{limit}. This is the left-most diagonal line in Figure 19; unfished recruits per SSB (R/SSB_{unfish}) is a slope equivalent to the rightmost diagonal line.

The equilibrium SPR corresponding with the exploitable biomass limit is:

$$SPR_{limit} = \frac{R/SSB_{unfish}}{R/SSB_{limit}} \quad [19]$$

and is estimated to be 17.6%. This is equivalent to specifying SSB_{limit} equal to the average of the three years with the lowest biomasses in which the stock has demonstrated sustainability. Additionally, equations [17, 19] are solved for the fishing mortality rates that correspond with SPR_{limit} and a SPR_{target} discussed below.

5.2 Overfishing, Overfished, and Target Definitions

The existing Louisiana blue crab data does not allow reliable estimates of MSY. Therefore, we have defined a limit based upon the history of the fishery as defined above (i.e., a 17.6% SPR_{limit}). The fishing mortality rate limit F_{limit} and SSB_{limit} that are equivalent to this SPR_{limit} are estimated as 1.02 $years^{-1}$ and 15.53 million pounds, respectively (Table 16).

The targets of fishing, (i.e., SSB, F, yield, and SPR) should not be so close to the limits that the limits are exceeded by random variability of the environment. Therefore, the biomass target reference point SSB_{target} is defined as $SSB_{limit} \times 1.5$. This biomass is achieved when there is a equilibrium SPR_{target} of 26.4% and F_{target} of 0.80 $years^{-1}$ (Table 16).

5.3 Stock Status

The history of the Louisiana blue stock relative to the biological reference points proposed above is illustrated in Figure 20. Fishing mortality rates exceeding F_{limit} indicate overfishing; stock biomasses below SSB_{limit} indicate the overfished condition. As these limits are specified, the Louisiana blue crab stock was considered overfished 1995-1996 and experienced overfishing in 2002.

5.4 Control Rules

There are currently no harvest control rules established for the LA blue crab fishery associated with the biological reference points described above. It is important to note that reference points alone cannot prevent unsustainable harvest from occurring. Pre-specified 'decision rules' need to be in place detailing the management response to be taken when the limits are approached or exceeded (including the required frequency of assessment). Once these rules are specified, an updated fishery management plan is needed specifically detailing them.

7. Research and Data Needs

Research emphasis on the Louisiana blue crab fishery is lacking, particularly in consideration of the value and size of the fishery (Guillory et al. 1996). The authors suggest that blue crab research done on the Atlantic coast may not be applicable to Gulf of Mexico populations. Based on this assessment, the following research and data needs are identified as priorities for future assessment of the Louisiana blue crab stock.

The biological reference point limits defined in this assessment allow for the objective evaluation of stock status in terms of exploitable biomass and fishing mortality (i.e., levels that allow for sustainable production). Reference point targets that provide guidance for optimal harvest strategies (e.g., the fishing mortality rate that produces optimal yield) are also needed. Efforts to define these targets in terms of optimal yield should be an ongoing priority.

Estimates of natural mortality in this assessment are based on assumptions of longevity. Without the ability to directly age blue crabs with conventional methods (i.e., calcified hard parts), growth estimation and resulting longevity estimates remain difficult to quantify. Estimates of these life history parameters for the Louisiana blue crab stock, perhaps from tagging studies, would aid in refining life history assumptions in future assessments.

Assessment of regional or basin-specific sub-populations could differentiate exploitation rates and stock status within the state. If available data is adequate for regional assessment, results could be used to determine if regional management is an effective alternative to optimize yield within the state.

Factors influencing year-class strength and the survival of recruits to exploitable life stages are not well understood. Investigation of these factors could elucidate causes of inter-annual variation in abundance as well as the underlying stock-recruitment relationship of the Louisiana blue crab stock. Contributing factors could also be used in development of predictive models allowing for short-term forecasts for resource managers and industry.

Equal weighting of the process and observation error components and the assumed structure of the process error in this assessment could inadequately characterize the observations and underlying population dynamics of the Louisiana blue crab stock. Independent estimates of process and observation error variances would allow for an alternative defensible weighting scenario. The effects of alternative process error structure should also be investigated.

The relationship between wetlands losses and the continuation of fishery production within Louisiana has been discussed by numerous authors. Understanding this relationship as it applies to the Louisiana blue crab stock should be an ongoing priority.

In addition to research specific to the Louisiana blue crab stock, continuous fishery dependent monitoring programs, as part of a comprehensive monitoring plan, are needed. Differences in exploitation rates of male and female blue crabs likely exist. Continuous information on size and sex distributions of the commercial and recreational harvest are not available. Continuous harvest data for the recreational sector is also lacking. These data would allow for relaxed assumptions in future sex-specific assessments of the Louisiana blue crab stock.

Fishery dependent data alone is not sufficient to accurately assess stock status and trends in abundance. Consistent fishery independent monitoring, in addition to fishery dependent monitoring, are integral components of this ability. Present monitoring programs should be assessed for adequacy with respect to their ability to evaluate stock status and should be modified or enhanced to optimize their capabilities.
Efforts should specifically be made to assess changes in fixed station characteristics over time. Results could then be used to test sensitivities of catch per unit effort derived from the fishery independent trawl survey to long term changes in station characteristics and to minimize the influence of these changes on future assessment.

8. Literature Cited

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9. Tables

Table 1: Louisiana blue crab *Callinectes sapidus* landings and dockside value. Landings and values, 1968-1998, are taken from NMFS statistical records. Landings and values, 1999-2009 (shaded values), are taken from the LDWF Trip Ticket Program. Landings are millions of pounds. Values are millions of dollars.

	Total		**Hard crab**		**% Hard crabs**		**Soft/peeler**		**% Soft/peeler**	
Year	*Landings*	*Value*	*Landings*	*Value*	*Landings*	*Value*	*Landings*	*Value*	*Landings*	*Value*
1968	9.83	1.01	9.55	0.81	97.11	79.64	0.28	0.21	2.89	20.36
1969	11.80	1.23	11.60	1.07	98.33	86.93	0.20	0.16	1.67	13.07
1970	10.34	1.01	10.25	0.93	99.13	92.11	0.09	0.08	0.87	7.89
1971	12.31	1.38	12.19	1.26	98.97	90.90	0.13	0.13	1.03	9.10
1972	15.18	1.89	15.08	1.78	99.33	94.21	0.10	0.11	0.67	5.79
1973	23.20	2.94	23.08	2.81	99.48	95.53	0.12	0.13	0.52	4.47
1974	20.74	2.83	20.64	2.70	99.54	95.51	0.10	0.13	0.46	4.49
1975	17.25	2.67	17.14	2.51	99.36	94.18	0.11	0.16	0.64	5.82
1976	15.30	3.21	15.21	3.06	99.42	95.48	0.09	0.14	0.58	4.52
1977	16.38	4.33	16.15	3.77	98.63	86.86	0.22	0.57	1.37	13.14
1978	15.21	3.47	15.07	3.19	99.13	92.04	0.13	0.28	0.87	7.96
1979	21.48	5.11	21.33	4.78	99.32	93.40	0.15	0.34	0.68	6.60
1980	18.30	4.60	18.18	4.33	99.35	94.06	0.12	0.27	0.65	5.94
1981	16.34	4.71	16.24	4.47	99.39	94.94	0.10	0.24	0.61	5.06
1982	17.45	5.28	17.28	4.84	99.06	91.82	0.16	0.43	0.94	8.18
1983	19.72	6.66	19.62	6.37	99.49	95.64	0.10	0.29	0.51	4.36
1984	29.69	8.40	29.62	8.19	99.75	97.58	0.08	0.20	0.25	2.42
1985	29.93	8.59	29.85	8.39	99.73	97.68	0.08	0.20	0.27	2.32
1986	31.69	9.48	31.61	9.30	99.75	98.09	0.08	0.18	0.25	1.91
1987	52.48	20.51	52.34	20.13	99.74	98.19	0.14	0.37	0.26	1.81
1988	53.72	21.89	53.55	21.45	99.70	97.99	0.16	0.44	0.30	2.01
1989	33.56	15.20	33.39	14.78	99.49	97.23	0.17	0.42	0.51	2.77
1990	39.14	14.83	38.89	14.21	99.36	95.81	0.25	0.62	0.64	4.19
1991	51.29	17.77	51.09	17.47	99.61	98.32	0.20	0.30	0.39	1.68
1992	51.98	27.20	51.74	26.67	99.54	98.04	0.24	0.53	0.46	1.96
1993	45.95	24.47	45.85	24.04	99.79	98.26	0.10	0.43	0.21	1.74
1994	36.76	22.53	36.66	22.09	99.73	98.07	0.10	0.44	0.27	1.93
1995	36.97	29.54	36.91	29.05	99.86	98.36	0.05	0.48	0.14	1.64
1996	40.00	24.48	39.90	23.96	99.75	97.89	0.10	0.52	0.25	2.11
1997	43.53	27.74	43.44	27.14	99.80	97.86	0.09	0.59	0.20	2.14
1998	43.66	30.74	43.48	29.34	99.59	95.45	0.18	1.40	0.41	4.55
1999	46.66	26.21	46.35	25.49	99.33	97.24	0.31	0.72	0.67	2.76
2000	52.03	34.47	51.43	33.30	98.84	96.59	0.60	1.18	1.16	3.41
2001	41.79	32.01	41.39	30.94	99.04	96.65	0.40	1.07	0.96	3.35
2002	50.12	30.69	49.75	29.77	99.26	96.99	0.37	0.92	0.74	3.01
2003	48.09	33.63	47.70	32.60	99.20	96.94	0.38	1.03	0.80	3.06
2004	44.40	29.70	44.08	28.83	99.26	97.08	0.33	0.87	0.74	2.92
2005	38.11	27.40	37.89	26.83	99.42	97.89	0.22	0.58	0.58	2.11
2006	53.47	32.41	53.32	32.01	99.73	98.75	0.14	0.41	0.27	1.25
2007	45.97	35.58	45.76	35.03	99.55	98.44	0.20	0.55	0.45	1.56
2008	44.32	34.36	44.21	34.07	99.77	99.14	0.10	0.29	0.23	0.86
2009	52.94	37.20	52.73	36.65	99.60	98.53	0.21	0.55	0.40	1.47

Table 2: Percent contribution by state of Gulf of Mexico blue crab *Callinectes sapidus* hard crab landings from the LDWF Trip Ticket Program and NMFS statistical records, 1999-2009.

	%Hard crab landings by state				
Year	Alabama	Florida (GOM)	Louisiana	Mississippi	Texas
1999	5.50	16.12	67.60	1.34	9.44
2000	7.02	9.41	75.51	1.23	6.83
2001	4.55	8.42	76.66	0.80	9.56
2002	3.93	8.37	75.88	1.09	10.73
2003	4.66	11.25	75.14	1.38	7.58
2004	5.53	13.31	73.23	1.35	6.58
2005	2.06	14.69	76.12	0.86	6.27
2006	3.54	12.73	79.13	1.67	2.92
2007	4.42	10.52	77.79	1.28	5.98
2008	3.66	5.34	84.72	0.92	5.36
2009	2.47	5.54	86.27	0.92	4.81

Table 3: Percent contribution by gear of Louisiana blue crab *Callinectes sapidus* hard crab landings from the LDWF Trip Ticket Program, 1999-2009

	%Hard crab landings by gear		
Year	Pots/traps	Handlines	Trawl/skimmers
1999	99.74	0.01	0.25
2000	99.61	0.12	0.27
2001	99.52	0.04	0.44
2002	99.63	0.03	0.34
2003	99.59	0.01	0.40
2004	99.76	0.00	0.23
2005	99.95	0.03	0.02
2006	99.98	0.00	0.02
2007	99.93	0.05	0.03
2008	99.94	0.00	0.06
2009	99.91	0.01	0.08

Table 4: Percent contribution by month of Louisiana blue crab *Callinectes sapidus* hard crab landings from the LDWF Trip Ticket Program, 1999-2009.

	%Hard crab landings by month											
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	6.8	4.0	4.1	6.4	9.5	14.3	14.7	10.7	7.1	8.8	8.4	5.4
2000	4.9	3.6	5.1	6.7	9.9	13.0	16.1	12.2	7.9	8.3	7.7	4.8
2001	2.8	4.8	2.2	3.8	7.0	11.3	16.9	12.1	11.2	11.2	10.1	6.6
2002	4.1	1.7	2.3	6.7	8.9	12.9	13.9	12.5	8.8	9.4	9.8	9.1
2003	4.6	5.1	2.9	5.7	10.1	13.2	15.5	10.1	8.7	8.7	7.9	7.4
2004	4.6	2.9	4.5	7.2	10.0	13.0	14.5	10.9	7.9	10.2	8.8	5.6
2005	5.6	3.1	2.9	6.0	10.5	14.6	16.1	12.2	4.0	7.9	8.5	8.7
2006	5.3	4.6	4.1	5.9	10.4	12.8	14.0	13.3	9.1	8.0	6.6	6.0
2007	5.5	5.6	4.0	5.5	9.1	12.6	14.1	13.0	8.0	8.3	7.5	6.8
2008	4.1	4.3	3.1	6.4	8.5	11.6	14.5	9.9	5.7	11.2	10.0	10.6
2009	6.6	4.8	4.0	6.6	10.7	13.5	11.3	12.1	8.3	8.2	7.0	6.9

Table 5: Percent contribution by basin of Louisiana blue crab *Callinectes sapidus* hard crab landings from the LDWF Trip Ticket Program, 1999-2010.

	%Hard crab landings by basin							
Year	Pontchartrain	Terrebonne	Barataria	Atchafalaya/ Vermilion-Teche	Mississippi	Calcasieu	Mermentau	Sabine
1999	34.08	22.47	15.31	16.49	4.91	4.61	2.07	0.07
2000	18.92	24.25	13.35	27.15	12.59	2.57	1.17	0.00
2001	17.78	36.46	15.04	19.76	6.60	2.35	1.64	0.37
2002	23.22	28.94	21.96	16.85	4.53	3.02	1.40	0.09
2003	28.46	28.48	18.30	16.08	4.81	2.54	1.33	0.00
2004	29.13	24.00	20.64	16.78	4.72	3.31	1.39	0.03
2005	20.19	27.90	22.63	21.01	3.91	2.89	1.45	0.03
2006	24.75	20.07	20.66	22.20	5.40	4.33	2.46	0.12
2007	27.16	23.04	20.95	15.53	3.81	6.72	2.79	0.00
2008	28.01	27.21	19.40	13.54	2.60	6.20	3.03	0.00
2009	30.64	25.87	18.14	13.69	2.47	5.73	3.47	0.00
2010	35.15	20.35	16.35	14.90	1.97	7.49	3.79	0.00

Table 6: Size-at-age and seasonal Gompertz growth parameters of blue crab *Callinectes sapidus.* Size-at-age data is taken from Tagatz (1968) and the LDWF fishery independent trawl survey. The shaded areas represent the average size-at-maximum-age of female crabs from the trawl survey, 1967-2009, estimated as the arithmetic mean size of female crabs that are $\geq 160mm$. This size corresponds with 100% sexual maturity (Guillory and Hein, 1999b). A maximum age of 3 years is assumed. Sizes are carapace-widths in mm. The non-seasonal Gompertz parameters are derived using the average size-at-age.

	Month of Hatch			
Age	*April*	*July*	*October*	*mean*
1	1[1]	1[1]	1[1]	1
2	5	5	5	5
3	12	12	8	11
4	23	23	10	19
5	46	46	12	35
6	58	46	15	40
7	90	58	29	59
8	113	58	46	72
9	113	72	72	86
10	113	90	90	98
11	113	113	113	113
12	142	142	142	142
36	172	172	172	172

[1]larvae

Females $\geq 160mm$			
mean	*n*	*stdev*	*max*
172	7227	9	303

Gompertz parameters				
	Jan-Apr	*May-Aug*	*Sept-Dec*	*non-seasonal*
CW_∞	164.8	175.9	174.8	174.5
α	-4.9	-4.6	-19.8	-5.5
β	-3.5	-2.6	-4.4	-3.0

Table 7: Size-at-capture matrix of Louisiana blue crab *Callinectes sapidus* is used to identify crabs that will not recruit to the fishery during the survey year. Cells represent carapace-widths at capture in mm from the LDWF fishery independent trawl survey. Crabs not fully-selected by the survey gear ($< 25mm$) are not shown (i.e., blank cells). Month of capture represents samples from the trawl survey. Month of hatch represents monthly cohorts. Cells above the diagonal represent size-at-capture of the current year-class. Cells below the diagonal are size-at-capture of the previous year-class. The shaded area represents cohorts that will not recruit to the fishery during the survey year. Carapace widths in bold represent the maximum size-at-capture of crabs that will not recruit to the fishery during the survey year. Seasonal size-at-age (Jan-Apr, May-Aug, and Sept-Dec) is estimated from Gompertz growth models.

Month of Hatch	Month of Capture											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Jan				29	45	63	80	96	110	122	132	140
Feb	140				29	45	63	80	96	110	122	132
Mar	132	140				29	**45**	**63**	**80**	**96**	**110**	**122**
Apr	122	132	140				29	45	63	80	96	110
May	85	98	110	120					31	44	57	71
Jun	71	85	98	110	120					31	44	57
Jul	57	71	85	98	110	120					31	44
Aug	44	57	71	85	98	110	120					31
Sept			28	50	73	95	115	131				
Oct				28	50	73	95	115	131			
Nov					28	50	73	95	115	131		
Dec						28	50	73	95	115	131	

Table 8: Catch-per-unit-effort of fully-recruited Louisiana blue crab *Callinectes sapidus.* Abundance indices are the delta-lognormal mean of fully-recruited crabs per tow from the LDWF fishery-independent trawl survey, 1967-2009. Fully-recruited crabs are $\geq 125mm$ carapace width. Shaded areas represent the maximum of the monthly-cpue distributions.

	Catch-per-unit-effort (fully-recruited)													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**mean**	**CV**
1967	1.4	0.3	1.4	0.7	1.0	1.5	1.3	1.2	1.0	0.7	0.5	0.8	0.9	0.5
1968	0.5	0.3	0.8	1.1	0.7	1.3	1.0	0.6	0.8	0.8	0.5	0.4	0.7	0.5
1969	0.3	0.2	0.4	0.8	0.7	1.2	0.9	0.9	0.7	0.8	0.6	1.4	0.7	0.6
1970	0.7	1.3	1.4	1.8	1.0	1.0	1.1	0.9	1.3	0.6	1.2	1.2	1.1	0.5
1971	0.6	0.7	1.3	1.1	1.8	1.7	1.4	1.3	0.8	0.6	0.6	0.9	1.1	0.5
1972	0.7	0.9	1.7	1.0	0.8	1.2	0.5	1.0	0.9	0.8	0.8	0.5	0.9	0.5
1973	0.2	0.4	0.6	0.7	1.3	1.2	1.8	1.2	0.8	0.8	0.9	0.6	0.9	0.5
1974	0.7	0.5	0.8	1.2	1.4	1.9	1.4	1.3	0.7	1.0	0.8	0.5	1.0	0.5
1975	0.8	0.5	0.5	0.6	0.7	1.1	1.9	0.9	0.6	0.6	0.6	0.2	0.8	0.5
1976	0.2	0.7	0.7	0.9	0.4	0.8	0.6	0.6	0.2	0.1	0.2	0.2	0.5	0.6
1977	0.0	0.1	0.3	0.1	0.2	0.6	0.5	0.7	0.2	0.6	0.6	0.7	0.4	0.7
1978	0.2	0.1	0.2	0.1	0.5	0.7	1.0	0.6	0.5	0.5	0.8	0.2	0.5	0.7
1979	0.0	0.2	0.6	0.5	0.4	1.4	1.5	0.9	0.9	0.9	0.7	0.4	0.8	0.6
1980	0.7	0.1	0.5	0.9	2.0	1.6	1.5	0.9	0.8	0.9	0.4	0.9	1.0	0.5
1981	0.1	0.2	0.5	0.4	1.0	1.9	1.2	1.2	1.0	1.0	0.6	0.3	0.9	0.5
1982	0.4	0.1	0.2	0.6	0.7	1.0	1.2	1.0	0.7	0.4	0.2	0.3	0.6	0.5
1983	0.3	0.3	0.2	0.3	0.4	0.9	1.4	1.1	0.8	0.4	0.2	0.5	0.6	0.5
1984	0.2	0.4	0.7	0.6	0.8	1.2	2.1	1.1	0.7	0.5	0.4	0.3	0.9	0.5
1985	0.2	0.3	0.6	0.9	1.4	1.4	1.3	0.6	0.5	0.5	0.5	0.4	0.8	0.5
1986	0.2	0.5	0.4	0.8	0.8	1.6	1.4	0.6	0.5	0.4	0.3	0.4	0.7	0.6
1987	0.4	0.3	0.2	0.5	0.9	1.1	1.0	0.6	0.5	0.3	0.3	0.3	0.6	0.6
1988	0.3	0.3	0.5	0.7	0.6	0.6	0.7	0.7	0.4	0.4	0.2	0.0	0.5	0.6
1989	0.1	0.1	0.2	0.1	0.5	1.2	0.8	0.7	0.4	0.3	0.1	0.1	0.4	0.6
1990	0.2	0.5	0.3	0.5	1.1	1.6	1.6	0.9	0.8	0.7	0.5	0.3	0.8	0.5
1991	0.6	0.5	0.5	0.7	1.0	1.4	1.0	0.9	0.4	0.3	0.2	0.2	0.7	0.5
1992	0.1	0.2	0.2	0.3	0.5	0.5	0.6	0.2	0.5	0.1	0.2	0.4	0.3	0.7
1993	0.1	0.1	0.1	0.1	0.3	0.8	0.9	0.5	0.5	0.4	0.3	0.1	0.4	0.6
1994	0.2	0.2	0.3	0.2	0.4	0.6	0.5	0.2	0.1	0.3	0.1	0.2	0.3	0.7
1995	0.2	0.1	0.1	0.1	0.2	0.3	0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.9
1996	0.1	0.1	0.2	0.1	0.2	0.3	0.2	0.3	0.2	0.2	0.3	0.1	0.2	0.8
1997	0.1	0.1	0.0	0.1	0.2	0.6	0.5	0.3	0.3	0.4	0.3	0.2	0.3	0.7
1998	0.2	0.1	0.1	0.1	0.1	0.6	0.7	0.5	0.4	0.3	0.3	0.2	0.3	0.7
1999	0.1	0.2	0.2	0.2	0.4	0.7	0.8	0.6	0.1	0.2	0.1	0.1	0.3	0.6
2000	0.2	0.2	0.1	0.3	0.7	0.6	0.5	0.3	0.2	0.1	0.1	0.1	0.3	0.7
2001	0.0	0.1	0.1	0.0	0.1	0.5	0.5	0.3	0.3	0.2	0.3	0.1	0.2	0.8
2002	0.2	0.1	0.1	0.1	0.2	0.5	0.9	0.7	0.4	0.1	0.5	0.2	0.3	0.6
2003	0.1	0.1	0.1	0.1	0.2	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.2	0.7
2004	0.0	0.2	0.1	0.1	0.2	0.6	0.5	0.4	0.2	0.2	0.3	0.1	0.2	0.7
2005	0.2	0.1	0.1	0.0	0.1	0.7	1.1	1.3	1.4	0.6	0.7	0.6	0.5	0.5
2006	0.9	0.8	0.5	0.6	1.5	2.5	2.4	1.3	0.7	0.5	0.6	0.4	1.1	0.5
2007	0.4	0.3	0.3	0.3	0.3	1.0	1.1	0.9	0.5	0.4	0.2	0.2	0.5	0.6
2008	0.2	0.4	0.1	0.1	0.2	0.6	0.8	0.6	0.4	0.4	0.4	0.6	0.4	0.6
2009	0.6	0.4	0.2	0.2	0.7	1.3	1.4	0.6	0.3	0.2	0.3	0.2	0.5	0.6
mean	0.3	0.3	0.3	0.4	0.6	1.0	1.0	0.7	0.5	0.4	0.4	0.3		
CV	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6		

Table 9: Catch-per-unit-effort of Louisiana blue crab *Callinectes sapidus* recruits. Recruits are crabs that will grow to legal size during the survey year. Abundance indices are the delta-lognormal mean of recruit crabs per tow from the LDWF fishery-independent trawl survey, 1967-2009. Recruits are crabs $\geq 25mm$ and $< 125mm$ carapace width identified by the size-at-capture matrix (Table 11). Shaded areas represent the maximum of the monthly-cpue distributions.

Catch-per-unit-effort (recruits)														
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**mean**	**CV**
1967	1.8	1.0	2.5	2.8	3.9	2.4	1.7	0.7	0.5	0.3	0.1	0.1	1.1	0.4
1968	1.2	1.3	2.0	2.0	2.9	3.5	1.4	0.6	0.4	0.2	0.1	0.1	1.3	0.4
1969	1.1	1.5	1.7	2.9	2.2	2.5	0.6	0.5	0.5	0.2	0.1	0.2	1.6	0.4
1970	2.4	2.2	2.5	2.5	1.5	2.0	1.4	0.5	0.5	0.3	0.1	0.0	1.2	0.4
1971	2.1	2.1	4.1	2.4	4.7	3.1	1.9	0.6	0.2	0.1	0.0	0.1	1.5	0.3
1972	4.4	5.3	2.6	2.9	1.8	2.9	1.1	0.7	0.6	0.4	0.1	0.1	1.6	0.3
1973	1.8	2.2	1.8	2.1	5.0	2.9	2.0	0.9	0.7	0.3	0.1	0.1	1.7	0.3
1974	1.6	2.2	2.3	2.7	3.3	3.7	1.2	0.7	0.3	0.3	0.1	0.0	1.7	0.3
1975	2.1	1.8	1.8	1.4	2.3	2.1	1.6	0.6	0.3	0.2	0.0	0.1	1.3	0.4
1976	0.4	0.7	1.7	1.3	1.1	1.9	0.6	0.2	0.2	0.1	0.0	0.0	0.6	0.4
1977	0.6	1.8	1.5	1.1	1.6	1.6	0.5	0.3	0.1	0.2	0.1	0.0	0.8	0.5
1978	1.8	2.3	1.3	2.0	3.0	2.5	1.3	0.5	0.5	0.1	0.1	0.0	1.0	0.4
1979	2.0	2.3	5.6	2.2	2.3	6.4	3.0	1.3	1.3	0.4	0.2	0.1	2.2	0.3
1980	3.6	2.5	2.8	5.0	6.2	5.8	1.8	0.7	0.3	0.5	0.0	0.2	2.4	0.2
1981	1.0	1.3	1.7	2.4	5.3	5.0	1.4	0.7	0.8	0.4	0.0	0.0	1.8	0.3
1982	1.4	1.7	4.6	3.5	3.2	5.1	2.8	1.4	0.9	0.3	0.0	0.1	2.2	0.2
1983	2.7	4.0	2.8	2.7	2.6	5.1	3.4	1.5	0.6	0.2	0.1	0.0	2.3	0.3
1984	2.0	1.7	2.7	3.2	3.2	3.2	2.4	0.9	0.6	0.2	0.1	0.0	1.8	0.3
1985	0.8	2.0	2.8	3.2	4.1	3.5	1.8	0.7	0.6	0.2	0.1	0.0	1.8	0.3
1986	1.1	3.0	2.6	2.6	2.3	3.1	2.0	0.5	0.4	0.3	0.1	0.1	1.7	0.3
1987	1.4	1.6	2.7	2.9	4.5	3.3	1.9	1.3	0.7	0.2	0.1	0.0	2.0	0.3
1988	3.3	4.2	4.4	5.3	4.9	3.1	2.0	1.2	0.6	0.2	0.0	0.0	2.2	0.2
1989	1.9	2.1	3.4	2.3	3.3	4.2	1.6	0.9	0.5	0.2	0.1	0.0	1.7	0.3
1990	1.4	3.3	3.7	5.0	5.2	5.3	2.8	1.1	1.0	0.5	0.3	0.0	2.5	0.2
1991	3.3	6.0	4.0	4.7	6.5	6.3	2.1	0.9	0.5	0.2	0.1	0.0	2.9	0.2
1992	5.1	2.1	1.9	1.9	2.2	2.5	1.2	0.3	0.3	0.1	0.0	0.1	1.4	0.3
1993	3.0	2.8	2.5	3.8	3.6	3.9	1.5	0.7	0.4	0.1	0.2	0.0	1.8	0.3
1994	5.6	3.3	4.0	5.3	4.8	3.6	0.9	0.3	0.1	0.1	0.0	0.0	2.2	0.2
1995	1.8	2.0	2.8	2.4	2.3	1.6	0.7	0.2	0.2	0.1	0.1	0.0	1.2	0.4
1996	3.4	1.2	2.1	2.1	2.2	1.6	0.7	0.6	0.2	0.0	0.0	0.0	1.2	0.4
1997	1.5	1.7	1.6	1.7	2.2	2.9	0.9	0.6	0.3	0.2	0.0	0.1	1.1	0.4
1998	3.5	2.8	2.2	1.3	1.8	4.5	1.2	0.6	0.3	0.1	0.0	0.0	1.4	0.3
1999	0.7	1.3	1.2	2.0	1.7	2.1	1.0	0.6	0.2	0.1	0.0	0.0	0.9	0.4
2000	1.9	3.2	2.4	1.9	2.0	1.3	0.6	0.3	0.2	0.1	0.0	0.0	1.0	0.4
2001	0.5	1.1	1.4	1.2	1.4	2.3	0.7	0.2	0.3	0.0	0.1	0.0	0.7	0.4
2002	0.6	1.7	1.4	1.3	1.9	1.8	0.8	0.2	0.2	0.0	0.0	0.0	0.8	0.4
2003	1.1	0.7	0.8	1.0	1.9	1.4	0.5	0.2	0.2	0.0	0.0	0.0	0.6	0.4
2004	0.8	2.6	1.7	1.2	1.3	2.3	0.7	0.3	0.2	0.1	0.0	0.0	0.9	0.4
2005	2.3	2.2	2.3	1.4	1.4	1.7	0.8	0.3	0.7	0.0	0.0	0.0	1.1	0.4
2006	1.6	2.4	2.3	2.8	3.3	2.2	0.8	0.2	0.3	0.1	0.1	0.0	1.3	0.3
2007	1.5	1.6	1.3	1.1	2.2	2.8	1.0	0.4	0.4	0.1	0.0	0.0	1.0	0.4
2008	0.9	1.9	1.5	1.0	1.5	1.5	0.7	0.4	0.1	0.0	0.0	0.0	0.8	0.5
2009	1.2	1.5	1.4	1.5	1.8	2.1	0.8	0.2	0.1	0.0	0.0	0.0	0.9	0.4
mean	1.8	2.2	2.3	2.3	2.8	2.9	1.3	0.6	0.4	0.2	0.1	0.0		
CV	0.3	0.3	0.3	0.3	0.2	0.2	0.4	0.5	0.6	0.8	0.8	0.9		

Table 10: Catch-per-unit-effort of pre-recruit Louisiana blue crab *Callinectes sapidus.* Pre-recruits are crabs that will not recruit to the fishery during the survey year. Abundance indices are the delta-lognormal mean of pre-recruit crabs per tow from the LDWF fishery-independent trawl survey, 1967-2009. Pre-recruits are crabs $\geq 25mm$ and $< 125mm$ carapace width identified by the size-at-capture matrix (Table 11). Shaded areas represent the maximum of the monthly-cpue distributions.

Catch-per-unit-effort (pre-recruits)														
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**mean**	**CV**
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.6	1.1	0.3	0.9	0.4	0.6
1968	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.8	1.4	1.0	1.1	0.4	0.5
1969	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.3	0.5	2.2	1.5	1.9	0.2	0.5
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.1	0.7	1.0	2.3	1.6	0.5	0.4
1971	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.5	0.5	1.0	2.1	3.2	0.7	0.3
1972	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.4	0.4	0.7	1.4	1.8	0.4	0.4
1973	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.5	0.7	1.1	1.0	1.6	0.5	0.4
1974	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.4	0.7	0.7	1.5	0.2	0.6
1975	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.4	1.0	0.9	0.6	0.2	0.5
1976	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.3	0.4	0.7	1.6	0.3	0.4
1977	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.2	0.9	1.9	1.2	0.3	0.5
1978	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.8	0.8	1.0	2.7	0.4	0.5
1979	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.8	2.5	1.9	1.6	2.0	0.8	0.4
1980	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.9	0.9	1.6	1.2	2.1	0.5	0.4
1981	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.9	1.5	0.5	1.3	0.4	0.4
1982	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.1	1.5	1.9	2.5	2.3	0.9	0.3
1983	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.9	0.9	1.9	0.9	1.9	0.5	0.4
1984	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.8	1.3	1.5	1.8	1.9	0.5	0.4
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	1.7	1.5	2.0	1.3	0.6	0.4
1986	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.4	0.8	1.7	1.0	4.0	0.5	0.4
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.4	1.5	1.4	0.8	2.8	0.6	0.3
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	1.0	0.8	1.1	0.3	0.4	0.5
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.5	1.4	1.8	0.9	1.9	0.5	0.4
1990	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.7	1.7	2.3	1.9	2.9	0.8	0.3
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.4	1.5	1.2	0.7	1.5	0.4	0.4
1992	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.6	1.0	0.7	0.6	1.2	0.4	0.4
1993	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.8	1.7	1.5	3.4	2.4	0.8	0.3
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.7	0.7	1.4	3.3	1.7	0.6	0.3
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.3	0.9	1.2	2.0	1.8	0.4	0.4
1996	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.6	0.7	0.6	1.8	1.7	0.4	0.4
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.2	1.7	2.6	2.4	2.1	0.9	0.3
1998	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.6	0.8	0.6	0.8	0.3	0.5
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.3	1.1	0.6	1.4	0.5	0.3
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.9	0.6	0.8	1.2	0.3	0.4
2001	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.9	0.6	0.7	1.0	0.3	0.5
2002	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.5	0.4	0.7	1.1	0.6	0.3	0.5
2003	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.4	0.7	0.4	0.9	1.4	0.3	0.4
2004	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.6	0.8	0.9	1.5	2.0	0.5	0.4
2005	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.2	1.1	0.5	1.1	1.2	0.3	0.5
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.3	0.4	0.5	0.6	0.2	0.6
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.3	0.5	0.6	0.7	0.2	0.6
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.4	0.4	0.5	0.6	0.2	0.6
2009	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.4	0.6	0.5	0.8	0.2	0.6
mean	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.9	1.0	1.1	1.4		
CV	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.5	0.4	0.4	0.3	0.3		

Table 11: Catch-at-size of Louisiana blue crab *Callinectes sapidus* and sampling effort from the LDWF fishery-independent trawl survey, 1967-1981. Size-bins are $5mm$ carapace-width intervals. Effort is trawl tows per year. The fully-recruited abundance index is developed from size-bins $\geq 125mm$. Recruit and pre-recruit abundance indices are developed from size-bins $25mm - 120mm$. Crabs $< 25mm$ are excluded from index development.

Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Effort	416	910	453	324	648	973	1453	1144	658	607	425	344	480	629	864
sizebin								Catch-at-size							
5	8	27	8	7	44	9	23	47	8	16	11	94	23	25	10
10	23	135	84	57	193	96	139	103	54	65	37	76	83	225	50
15	53	292	148	93	301	258	308	186	142	76	90	137	203	438	148
20	46	369	230	142	423	416	479	313	219	141	108	151	268	732	204
25	87	355	187	150	428	506	627	381	291	162	122	123	311	723	321
30	101	296	161	111	339	600	636	422	297	127	112	132	341	700	347
35	104	244	151	64	287	618	722	417	234	121	98	100	344	1237	382
40	89	219	112	80	247	516	635	447	183	108	75	64	359	1003	384
45	80	177	94	46	219	491	557	360	161	79	65	77	258	506	391
50	63	168	98	57	224	306	461	301	111	62	38	75	196	398	373
55	64	146	79	53	187	274	340	246	103	46	33	53	149	255	286
60	53	140	89	53	148	202	393	257	84	38	26	56	146	226	215
65	52	114	56	32	103	156	254	166	44	28	20	43	140	179	156
70	45	111	58	16	102	140	293	179	70	41	22	41	150	135	129
75	33	86	38	32	87	113	204	179	43	20	17	33	93	128	84
80	36	77	35	20	75	89	194	132	49	19	16	25	101	86	91
85	27	65	36	26	54	74	158	118	38	16	13	19	93	80	75
90	26	56	32	17	62	78	193	138	56	13	12	13	112	90	108
95	36	73	31	29	58	85	160	92	29	18	15	21	56	83	106
100	32	70	34	25	41	81	176	144	45	32	12	23	78	74	113
105	28	63	35	31	46	108	149	99	45	25	16	21	81	62	106
110	22	66	29	31	40	95	169	149	54	34	12	26	94	90	121
115	33	67	38	40	47	106	184	141	51	39	17	20	88	83	118
120	31	61	36	23	54	109	213	183	86	18	13	19	58	86	103
125	43	90	31	62	82	139	150	123	75	17	7	12	56	71	89
130	33	86	36	67	88	121	155	173	93	28	12	12	39	79	111
135	55	111	45	59	90	128	233	218	82	25	22	32	48	84	107
140	49	103	39	63	101	140	166	157	76	25	18	13	47	103	117
145	77	83	50	53	96	141	195	171	74	42	20	36	42	90	105
150	59	134	34	55	133	120	170	175	85	53	21	20	42	92	113
155	86	80	41	34	126	127	197	185	75	37	21	16	60	96	86
160	50	99	39	46	109	109	177	149	51	26	19	17	38	102	82
165	54	37	34	20	94	103	173	191	47	36	20	19	43	93	69
170	29	45	21	11	56	70	106	121	38	24	7	13	45	62	43
175	54	23	26	6	39	59	102	112	27	23	10	18	32	54	33
180	12	29	12	8	23	29	65	68	25	22	3	5	18	24	14
185	12	7	2	4	6	13	31	51	11	10	4	6	12	19	9
190	0	8	2	1	10	9	27	22	5	8	0	1	4	17	4
195	8	1	4	1	2	2	14	17	5	2	1	1	2	1	1
200	3	1	1	3	1	9	8	6	1	1	1	1	1	2	1
205	0	0	0	0	1	0	1	2	1	1	0	0	0	0	0
210	0	0	0	0	0	9	2	2	0	0	0	0	0	0	0
220	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
225	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
230	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
240	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
245	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
250	1	0	0	0	0	2	0	1	0	0	0	0	0	0	0
285	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

Table 12: Catch-at-size of Louisiana blue crab *Callinectes sapidus* and sampling effort from the LDWF fishery-independent trawl survey, 1982-1996. Size-bins are $5mm$ carapace-width intervals. Effort is trawl tows per year. The fully-recruited abundance index is developed from size-bins $\geq 125mm$. Recruit and pre-recruit abundance indices are developed from size-bins $25mm - 120mm$. Crabs $< 25mm$ are excluded from index development.

Year	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Effort	1286	1304	1197	1375	1120	1282	1299	1152	1299	1355	1275	1259	1223	1346	1322
sizebin	**Catch-at-size**														
5	33	48	11	5	2	5	14	9	17	69	9	27	14	5	32
10	276	296	159	126	16	78	54	108	204	392	123	147	131	83	121
15	628	938	490	422	159	281	274	355	614	801	342	725	663	367	528
20	794	1172	635	658	364	510	569	588	1089	1141	869	1379	1561	788	1002
25	989	1112	670	682	584	675	933	685	1201	1191	1555	1569	1705	906	946
30	900	886	569	573	557	830	904	812	1284	1107	1694	1458	1595	824	806
35	933	664	504	509	483	656	911	653	1215	1160	822	1118	1115	510	587
40	780	612	456	522	489	642	905	642	1312	1070	553	897	877	429	474
45	654	508	375	419	421	614	718	430	1182	933	366	698	653	291	315
50	536	533	380	540	404	537	589	327	765	792	287	421	516	232	259
55	285	365	203	339	199	338	507	282	590	747	200	357	321	175	132
60	345	372	208	316	214	341	494	271	644	637	165	287	288	190	161
65	291	254	155	237	174	270	405	240	515	442	115	250	233	130	114
70	256	233	205	211	186	264	289	206	480	357	95	158	173	112	88
75	189	245	162	201	124	195	223	184	404	311	90	139	140	94	87
80	233	189	163	165	144	219	197	163	226	340	81	128	155	84	80
85	181	202	112	103	113	163	164	164	279	278	70	106	97	79	63
90	208	185	184	131	137	195	178	107	287	248	179	103	97	69	39
95	140	198	145	112	110	144	131	132	231	244	46	92	91	66	41
100	166	177	188	167	130	187	164	117	299	280	60	97	76	59	56
105	152	163	117	126	104	172	121	84	244	192	60	82	66	61	44
110	163	171	172	151	127	234	149	110	250	240	62	85	79	56	41
115	111	134	148	173	110	130	109	106	244	254	53	83	46	36	33
120	121	142	157	171	114	212	119	85	220	222	415	57	53	31	43
125	110	154	140	128	102	111	82	115	199	158	70	54	38	22	28
130	129	182	188	182	160	133	109	89	249	156	56	86	52	32	34
135	131	136	137	146	103	103	90	84	211	157	48	73	25	29	37
140	163	123	178	151	133	124	96	67	224	163	74	72	56	12	49
145	112	99	147	142	112	83	76	84	176	117	42	72	43	18	15
150	110	141	227	175	170	110	107	77	215	179	55	76	57	20	40
155	85	111	119	131	113	85	104	75	167	153	67	103	36	15	22
160	94	108	159	133	104	83	78	56	150	135	61	69	37	22	33
165	74	73	98	79	63	46	74	59	78	75	33	38	22	9	18
170	54	80	108	103	48	30	59	26	96	59	24	27	24	8	27
175	47	32	60	69	24	15	40	11	71	41	14	20	9	11	4
180	22	24	55	37	23	7	20	5	21	27	7	10	15	5	9
185	21	6	25	9	5	5	9	3	14	20	3	11	8	2	4
190	7	2	9	16	2	4	3	3	4	5	5	2	5	1	1
195	5	0	1	2	1	0	3	1	2	5	1	4	3	1	1
200	0	0	1	1	0	0	0	0	0	6	0	0	1	2	0
205	0	1	0	0	0	0	0	0	2	0	1	1	0	0	0
210	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
215	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
220	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
225	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
230	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
245	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
260	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
270	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
300	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0

Table 13: Catch-at-size of Louisiana blue crab *Callinectes sapidus* and sampling effort from the LDWF fishery-independent trawl survey, 1997-2009. Size-bins are $5mm$ carapace-width intervals. Effort is trawl tows per year. The fully-recruited abundance index is developed from size-bins $\geq 125mm$. Recruit and pre-recruit abundance indices are developed from size-bins $25mm - 120mm$. Crabs $< 25mm$ are excluded from index development.

Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Effort	*1387*	*1445*	*1506*	*1467*	*1529*	*1509*	*1518*	*1447*	*1405*	*1486*	*1460*	*1501*	*1445*
sizebin							**Catch-at-size**						
5	27	9	2	17	46	47	6	68	39	55	119	122	81
10	88	79	134	94	450	693	209	250	223	254	746	543	384
15	440	583	406	414	967	609	584	954	924	673	1213	1017	648
20	922	1241	960	912	1012	768	825	1212	1547	991	1171	1052	713
25	1118	1187	999	980	753	1640	725	1148	1262	1002	902	703	576
30	993	817	820	712	577	963	541	863	824	690	487	390	405
35	811	540	633	564	398	317	333	546	448	463	324	314	276
40	562	495	492	400	305	207	228	311	266	323	203	192	195
45	455	351	332	311	224	183	194	245	214	266	163	144	148
50	272	272	206	252	132	140	108	122	121	157	144	125	134
55	215	238	183	198	125	135	102	131	125	179	128	90	137
60	183	145	121	150	107	83	79	104	82	115	98	81	100
65	142	143	118	113	73	96	62	79	54	97	55	69	79
70	99	106	77	87	59	62	53	72	53	67	53	41	81
75	97	96	67	63	44	51	37	41	43	62	45	37	58
80	94	82	59	44	54	48	40	44	52	47	60	40	51
85	75	81	61	56	22	40	18	27	27	47	42	27	37
90	90	58	67	60	37	25	30	27	27	48	45	24	61
95	67	63	52	36	21	28	28	18	23	45	31	22	37
100	66	65	56	40	31	39	23	36	44	88	51	35	60
105	61	71	58	47	19	27	17	25	34	63	41	33	55
110	68	59	39	36	37	40	28	38	31	92	58	31	58
115	48	61	43	36	18	49	17	35	32	71	45	40	65
120	66	63	59	67	36	36	45	43	49	93	79	41	62
125	47	51	53	53	19	48	18	33	55	95	79	49	58
130	50	63	62	51	31	59	31	23	41	102	82	66	82
135	44	63	73	35	24	44	14	24	66	142	78	59	89
140	47	52	77	47	35	80	37	40	115	215	110	79	123
145	37	52	64	45	29	50	21	26	79	193	120	58	96
150	54	60	78	51	38	98	34	40	144	278	118	85	142
155	37	51	70	46	33	57	38	47	114	239	115	102	132
160	38	50	66	61	54	86	43	51	183	318	140	98	154
165	33	36	53	38	18	50	24	37	123	194	85	82	113
170	27	37	24	52	40	50	37	43	124	195	54	76	117
175	22	22	19	29	14	29	18	28	60	94	42	56	73
180	12	9	11	17	22	25	29	39	102	140	66	45	87
185	3	5	4	14	5	13	21	9	29	31	12	22	15
190	1	8	6	8	9	10	10	6	23	40	8	20	28
195	0	1	2	5	3	2	3	1	6	9	4	9	6
200	1	0	1	1	0	2	2	4	2	10	1	1	2
205	0	2	0	1	1	2	0	0	1	2	0	0	0
210	0	0	0	0	0	0	0	0	1	0	0	1	0
215	0	0	0	0	0	0	0	0	1	0	0	0	0
220	0	0	0	0	0	0	0	1	0	0	0	0	0
225	0	0	0	1	0	0	0	0	0	0	0	0	0
230	0	0	0	0	0	0	0	0	0	0	0	1	0
245	0	0	0	0	0	0	0	0	0	0	0	0	1

Table 14: Catch-per-unit-effort of Louisiana blue crab *Callinectes sapidus.* Fully-recruited, recruit, and pre-recruit abundance indices are derived as the delta-lognormal mean catch-per-tow from the LDWF fishery-independent trawl survey, 1967-2009. The recruit abundance index r_y used in the catch-survey model is derived as the sum of pre-recruit cpue in $year$ and recruit cpue in $year + 1$. The shaded cells represent values not used as model inputs.

	Catch-per-unit-effort (crabs per tow)			***Model inputs***	
Year	*Fully-recruited*	*Recruits*	*Pre-recruits*	n_y	r_y
1967	*0.92*	*1.08*	*0.38*		
1968	*0.73*	*1.26*	*0.40*	*0.73*	*1.64*
1969	*0.65*	*1.60*	*0.22*	*0.65*	*1.99*
1970	*1.11*	*1.24*	*0.48*	*1.11*	*1.46*
1971	*1.07*	*1.51*	*0.65*	*1.07*	*1.99*
1972	*0.89*	*1.63*	*0.44*	*0.89*	*2.28*
1973	*0.93*	*1.65*	*0.45*	*0.93*	*2.09*
1974	*1.03*	*1.71*	*0.19*	*1.03*	*2.16*
1975	*0.80*	*1.32*	*0.23*	*0.80*	*1.51*
1976	*0.45*	*0.64*	*0.31*	*0.45*	*0.87*
1977	*0.36*	*0.78*	*0.30*	*0.36*	*1.08*
1978	*0.49*	*1.04*	*0.44*	*0.49*	*1.34*
1979	*0.76*	*2.16*	*0.80*	*0.76*	*2.60*
1980	*1.01*	*2.39*	*0.54*	*1.01*	*3.19*
1981	*0.88*	*1.75*	*0.39*	*0.88*	*2.30*
1982	*0.63*	*2.19*	*0.87*	*0.63*	*2.58*
1983	*0.63*	*2.29*	*0.55*	*0.63*	*3.15*
1984	*0.87*	*1.84*	*0.53*	*0.87*	*2.39*
1985	*0.79*	*1.81*	*0.55*	*0.79*	*2.34*
1986	*0.75*	*1.65*	*0.46*	*0.75*	*2.20*
1987	*0.57*	*1.97*	*0.56*	*0.57*	*2.44*
1988	*0.50*	*2.24*	*0.38*	*0.50*	*2.79*
1989	*0.41*	*1.75*	*0.48*	*0.41*	*2.12*
1990	*0.84*	*2.53*	*0.78*	*0.84*	*3.01*
1991	*0.70*	*2.86*	*0.41*	*0.70*	*3.63*
1992	*0.32*	*1.38*	*0.40*	*0.32*	*1.79*
1993	*0.38*	*1.82*	*0.80*	*0.38*	*2.23*
1994	*0.29*	*2.18*	*0.56*	*0.29*	*2.98*
1995	*0.14*	*1.17*	*0.44*	*0.14*	*1.74*
1996	*0.19*	*1.16*	*0.42*	*0.19*	*1.60*
1997	*0.26*	*1.13*	*0.87*	*0.26*	*1.55*
1998	*0.30*	*1.38*	*0.34*	*0.30*	*2.24*
1999	*0.32*	*0.93*	*0.46*	*0.32*	*1.27*
2000	*0.30*	*1.04*	*0.32*	*0.30*	*1.50*
2001	*0.21*	*0.74*	*0.34*	*0.21*	*1.07*
2002	*0.34*	*0.84*	*0.28*	*0.34*	*1.18*
2003	*0.20*	*0.65*	*0.33*	*0.20*	*0.92*
2004	*0.24*	*0.90*	*0.50*	*0.24*	*1.23*
2005	*0.54*	*1.10*	*0.32*	*0.54*	*1.60*
2006	*1.07*	*1.29*	*0.19*	*1.07*	*1.61*
2007	*0.51*	*1.00*	*0.24*	*0.51*	*1.19*
2008	*0.40*	*0.79*	*0.25*	*0.40*	*1.03*
2009	*0.54*	*0.94*	*0.21*	*0.54*	*1.19*

Table 15: Catch-survey model inputs and resulting estimates for the Louisiana blue crab *Callinectes sapidus* stock, 1968-2009. Descriptions of model inputs are: M = constant instantaneous natural mortality rate, C_y = harvest (as individuals), r_y = recruit catch-per-unit-effort (cpue), n_y = fully-recruited cpue, s_r = relative selectivity of recruits to fully-recruited crabs in the survey gear. Descriptions of model estimates are: $\hat{q}_n$ = predicted catchability of fully-recruited crabs to the survey gear, $\hat{r}_y$ = predicted recruit cpue, $\hat{n}_y$ = predicted fully-recruited cpue, n_y = calculated fully-recruited cpue (i.e., from log-normal process error) , R_y = recruit abundance, N_y = fully-recruited abundance, Z_y = instantaneous total mortality rate, u_y = exploitation rate, F_y = instantaneous fishing mortality rate. Nominal cpue is derived as the delta-lognormal catch per tow from the LDWF fishery-independent trawl survey. Recruits are crabs $\geq 25mm$ and $< 125mm$ carapace width. Fully-recruited crabs are $\geq 125mm$ carapace width. Abundance units are millions of individuals. Biomass units are millions of pounds.

Model inputs					***Model estimates***										
$M = 1.0$					$\hat{q}_n = 0.0054$										
Year	C_y	r_y	n_y	s_r	$\hat{r}_y$	$\hat{n}_y$	n_y	R_y	N_y	Z_y	u_y	F_y	R_y Biomass	N_y Biomass	$R_y + N_y$ Biomass
1968	*27.21*	*1.64*	*0.73*	*1.0*	*1.57*	*0.72*		*292*	*134*	*1.17*	*0.06*	*0.11*	*15.89*	*52.57*	*68.46*
1969	*31.85*	*1.99*	*0.65*	*1.0*	*2.16*	*0.71*	*0.75*	*403*	*132*	*1.01*	*0.06*	*0.09*	*21.34*	*54.30*	*75.64*
1970	*30.79*	*1.46*	*1.11*	*1.0*	*1.56*	*1.05*	*0.95*	*291*	*196*	*1.01*	*0.06*	*0.10*	*17.26*	*72.65*	*89.91*
1971	*33.47*	*1.99*	*1.07*	*1.0*	*1.93*	*0.95*	*0.86*	*359*	*178*	*1.15*	*0.06*	*0.10*	*16.27*	*72.20*	*88.48*
1972	*42.27*	*2.28*	*0.89*	*1.0*	*2.21*	*0.91*	*0.95*	*412*	*170*	*1.17*	*0.07*	*0.12*	*19.36*	*68.93*	*88.29*
1973	*62.77*	*2.09*	*0.93*	*1.0*	*2.13*	*0.97*	*1.01*	*397*	*181*	*1.17*	*0.11*	*0.18*	*22.72*	*75.36*	*98.08*
1974	*55.32*	*2.16*	*1.03*	*1.0*	*1.99*	*0.96*	*0.94*	*370*	*179*	*1.28*	*0.10*	*0.18*	*23.01*	*75.97*	*98.98*
1975	*48.84*	*1.51*	*0.80*	*1.0*	*1.32*	*0.82*	*0.91*	*247*	*152*	*1.39*	*0.12*	*0.23*	*13.04*	*60.23*	*73.27*
1976	*39.18*	*0.87*	*0.45*	*1.0*	*0.86*	*0.53*	*0.63*	*160*	*99*	*1.30*	*0.15*	*0.27*	*8.17*	*43.38*	*51.54*
1977	*43.12*	*1.08*	*0.36*	*1.0*	*1.18*	*0.38*	*0.38*	*219*	*71*	*1.20*	*0.15*	*0.26*	*9.48*	*29.61*	*39.09*
1978	*40.42*	*1.34*	*0.49*	*1.0*	*1.50*	*0.47*	*0.43*	*280*	*88*	*1.08*	*0.11*	*0.18*	*14.01*	*36.72*	*50.74*
1979	*58.10*	*2.60*	*0.76*	*1.0*	*2.55*	*0.67*	*0.59*	*474*	*125*	*1.20*	*0.10*	*0.17*	*26.01*	*51.97*	*77.98*
1980	*48.99*	*3.19*	*1.01*	*1.0*	*2.71*	*0.97*	*0.99*	*504*	*181*	*1.32*	*0.07*	*0.13*	*18.57*	*75.58*	*94.16*
1981	*46.65*	*2.30*	*0.88*	*1.0*	*1.93*	*0.98*	*1.20*	*360*	*183*	*1.38*	*0.09*	*0.16*	*20.57*	*71.13*	*91.70*
1982	*49.54*	*2.58*	*0.63*	*1.0*	*2.17*	*0.74*	*0.92*	*404*	*137*	*1.36*	*0.09*	*0.17*	*18.98*	*53.89*	*72.88*
1983	*57.61*	*3.15*	*0.63*	*1.0*	*2.78*	*0.75*	*0.91*	*517*	*139*	*1.29*	*0.09*	*0.16*	*26.22*	*53.02*	*79.24*
1984	*82.90*	*2.39*	*0.87*	*1.0*	*2.22*	*0.97*	*1.11*	*414*	*180*	*1.34*	*0.14*	*0.25*	*24.30*	*72.12*	*96.42*
1985	*84.26*	*2.34*	*0.79*	*1.0*	*2.17*	*0.83*	*0.90*	*404*	*155*	*1.36*	*0.15*	*0.28*	*22.52*	*61.69*	*84.20*
1986	*91.60*	*2.20*	*0.75*	*1.0*	*1.95*	*0.77*	*0.83*	*363*	*143*	*1.47*	*0.18*	*0.35*	*19.07*	*54.86*	*73.93*
1987	*156.68*	*2.44*	*0.57*	*1.0*	*2.23*	*0.62*	*0.70*	*416*	*116*	*1.72*	*0.29*	*0.62*	*23.22*	*42.90*	*66.12*
1988	*150.48*	*2.79*	*0.50*	*1.0*	*2.29*	*0.51*	*0.54*	*426*	*95*	*1.77*	*0.29*	*0.62*	*19.22*	*37.91*	*57.13*
1989	*99.68*	*2.12*	*0.41*	*1.0*	*2.30*	*0.47*	*0.54*	*429*	*88*	*1.32*	*0.19*	*0.35*	*19.94*	*33.18*	*53.13*
1990	*114.03*	*3.01*	*0.84*	*1.0*	*2.53*	*0.75*	*0.70*	*470*	*139*	*1.52*	*0.19*	*0.37*	*23.65*	*52.79*	*76.44*
1991	*147.17*	*3.63*	*0.70*	*1.0*	*2.32*	*0.71*	*0.83*	*431*	*133*	*1.90*	*0.26*	*0.58*	*22.18*	*51.54*	*73.72*
1992	*149.06*	*1.79*	*0.32*	*1.0*	*1.83*	*0.45*	*0.63*	*341*	*84*	*1.85*	*0.35*	*0.77*	*13.53*	*33.13*	*46.67*
1993	*130.01*	*2.23*	*0.38*	*1.0*	*1.70*	*0.36*	*0.36*	*316*	*67*	*1.97*	*0.34*	*0.78*	*10.18*	*26.29*	*36.48*
1994	*102.96*	*2.98*	*0.29*	*1.0*	*1.44*	*0.29*	*0.33*	*269*	*54*	*2.16*	*0.32*	*0.78*	*8.05*	*21.53*	*29.57*
1995	*107.01*	*1.74*	*0.14*	*1.0*	*1.38*	*0.20*	*0.30*	*257*	*37*	*2.02*	*0.36*	*0.85*	*8.92*	*14.57*	*23.50*
1996	*113.37*	*1.60*	*0.19*	*1.0*	*1.55*	*0.21*	*0.23*	*288*	*39*	*1.87*	*0.35*	*0.77*	*9.05*	*15.46*	*24.51*
1997	*123.39*	*1.55*	*0.26*	*1.0*	*1.59*	*0.27*	*0.28*	*296*	*50*	*1.87*	*0.36*	*0.79*	*9.89*	*19.94*	*29.82*
1998	*122.82*	*2.24*	*0.30*	*1.0*	*1.89*	*0.29*	*0.28*	*352*	*53*	*1.79*	*0.30*	*0.65*	*12.33*	*21.25*	*33.58*
1999	*130.86*	*1.27*	*0.32*	*1.0*	*1.50*	*0.36*	*0.40*	*279*	*68*	*1.90*	*0.38*	*0.84*	*9.05*	*26.74*	*35.80*
2000	*138.12*	*1.50*	*0.30*	*1.0*	*1.54*	*0.28*	*0.26*	*286*	*52*	*2.11*	*0.41*	*0.98*	*9.23*	*22.11*	*31.34*
2001	*107.41*	*1.07*	*0.21*	*1.0*	*1.44*	*0.22*	*0.22*	*268*	*41*	*1.70*	*0.35*	*0.72*	*7.96*	*17.80*	*25.76*
2002	*133.21*	*1.18*	*0.34*	*1.0*	*1.38*	*0.30*	*0.26*	*257*	*56*	*2.15*	*0.43*	*1.03*	*6.61*	*23.67*	*30.28*
2003	*119.14*	*0.92*	*0.20*	*1.0*	*1.37*	*0.20*	*0.19*	*255*	*36*	*1.97*	*0.41*	*0.93*	*7.59*	*16.62*	*24.21*
2004	*111.53*	*1.23*	*0.24*	*1.0*	*1.79*	*0.22*	*0.19*	*332*	*41*	*1.47*	*0.30*	*0.57*	*8.78*	*18.28*	*27.06*
2005	*93.47*	*1.60*	*0.54*	*1.0*	*2.16*	*0.46*	*0.37*	*403*	*86*	*1.13*	*0.19*	*0.32*	*10.81*	*39.11*	*49.91*
2006	*135.36*	*1.61*	*1.07*	*1.0*	*1.71*	*0.85*	*0.66*	*318*	*159*	*1.58*	*0.28*	*0.57*	*12.60*	*69.82*	*82.42*
2007	*122.93*	*1.19*	*0.51*	*1.0*	*1.48*	*0.52*	*0.50*	*276*	*98*	*1.65*	*0.33*	*0.67*	*10.58*	*40.74*	*51.32*
2008	*113.27*	*1.03*	*0.40*	*1.0*	*1.53*	*0.39*	*0.34*	*286*	*72*	*1.50*	*0.32*	*0.61*	*9.81*	*31.82*	*41.64*
2009	*134.57*	*1.19*	*0.54*	*1.0*		*0.43*	*0.34*	*222*	*80*				*10.18*	*35.14*	*45.32*

Table 16: Derivation and estimates of biological reference points for the Louisiana blue crab *Callinectes sapidus* stock. Fishing mortality units are $years^{-1}$. Biomass units are millions of pounds.

Biological Reference Points		
Parameters	*Derivation*	*Estimates*
SPR_{limit}	*Equations [17,19] and* SSB_{limit}	*17.6%*
SSB_{limit}	*Geometric mean of 3 lowest biomasses*	*15.53*
F_{limit}	*Equations [17,19] and* SPR_{limit}	*1.02*
SPR_{target}	*Equations [17,19] and* SSB_{target}	*26.4%*
SSB_{target}	$SSB_{limit} \times 1.5$	*23.29*
F_{target}	*Equations [17,19] and* SPR_{target}	*0.80*

10. Figures

Figure 1: Commercial hard crab landings and fishing effort for Louisiana blue crab *Callinectes sapidus*. Landings, 1967-1998, are taken from NMFS statistical records. Landings and fishing effort, 1999-2009, are taken from the LDWF Trip Ticket Program. Landings are millions of pounds. Fishing effort is thousands of trap fisher trips.

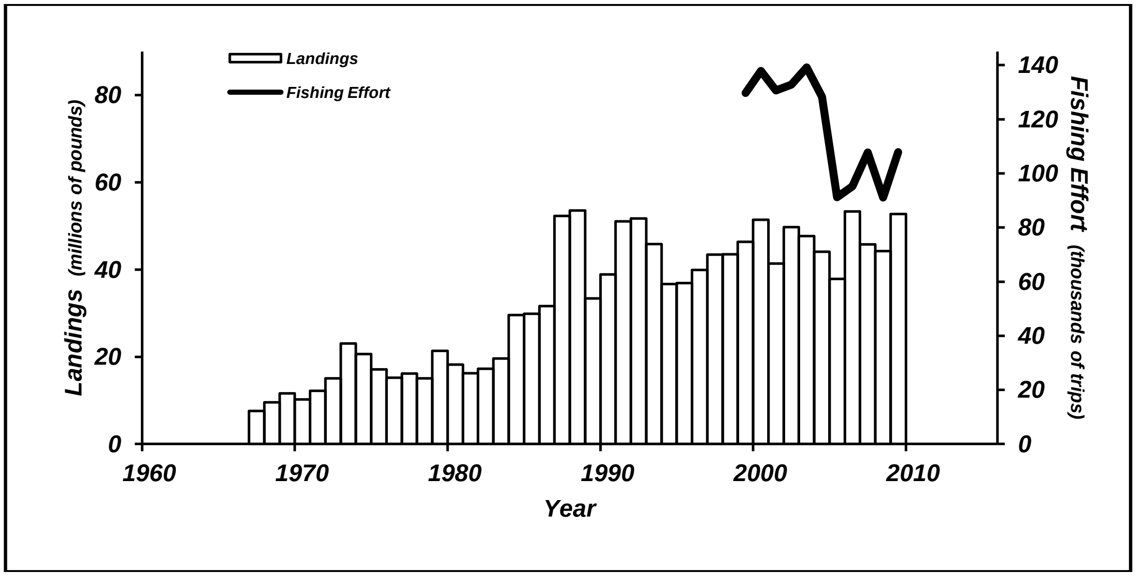


Figure 2: Catch-per-unit-effort of Louisiana blue crab *Callinectes sapidus.* Fishery-independent index is the delta-lognormal mean of fully-recruited (i.e., $\geq 125mm$) crabs per tow from the LDWF trawl survey, 1967-2009. Fishery-dependent index is the arithmetic mean pounds harvested per trip from the LDWF Trip Ticket Program, 1999-2009. Each index has been standardized to its individual long-term mean. The fishery-dependent index is not used in the assessment model, but is presented to validate trends in fishery-independent index.

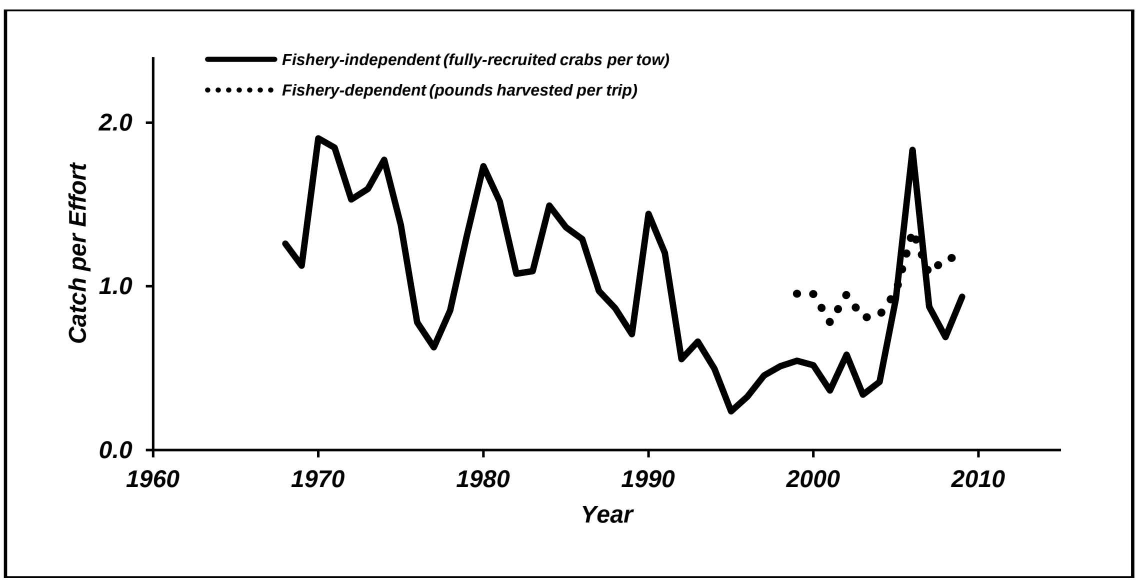


Figure 3: Size-at-age of blue crab *Callinectes sapidus*. Circles represent reported size-at-age from an April hatch (Tagatz, 1968). The triangle represents the average carapace-width of female crabs ≥160mm from the LDWF fishery-independent trawl survey coupled with an assumed maximum age of 3 years. The size 160mm corresponds with 100% sexually maturity (Guillory and Hein, 1997a). Size-at-age is estimated from Gompertz and von Bertalanffy growth models.

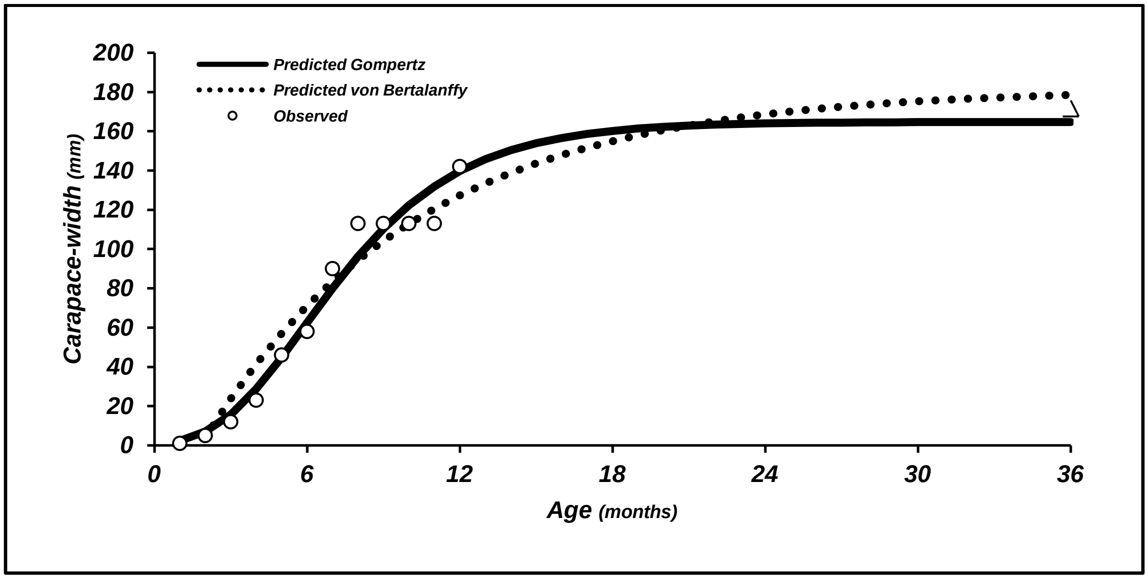


Figure 4: Size-at-age of blue crab *Callinectes sapidus*. Circles represent reported size-at-age from a July hatch (Tagatz, 1968). The triangle represents the average carapace-width of female crabs ≥160mm from the LDWF fishery-independent trawl survey coupled with an assumed maximum age of 3 years. The size 160mm corresponds with 100% sexually maturity (Guillory and Hein, 1997a). Size-at-age is estimated from Gompertz and von Bertalanffy growth models.

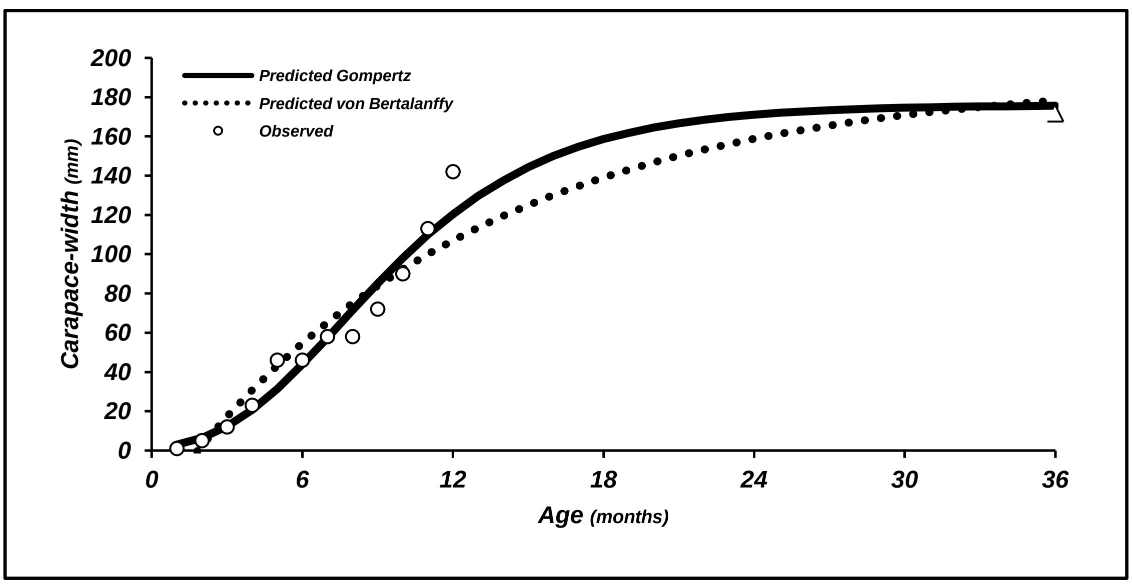


Figure 5: Size-at-age of blue crab *Callinectes sapidus*. Circles represent reported size-at-age from an October hatch (Tagatz, 1968). The triangle represents the average carapace-width of female crabs $\geq 160 mm$ from the LDWF fishery-independent trawl survey coupled with an assumed maximum age of 3 years. The size $160 mm$ corresponds with 100% sexually maturity (Guillory and Hein, 1997a). Size-at-age is estimated from Gompertz and von Bertalanffy growth models.

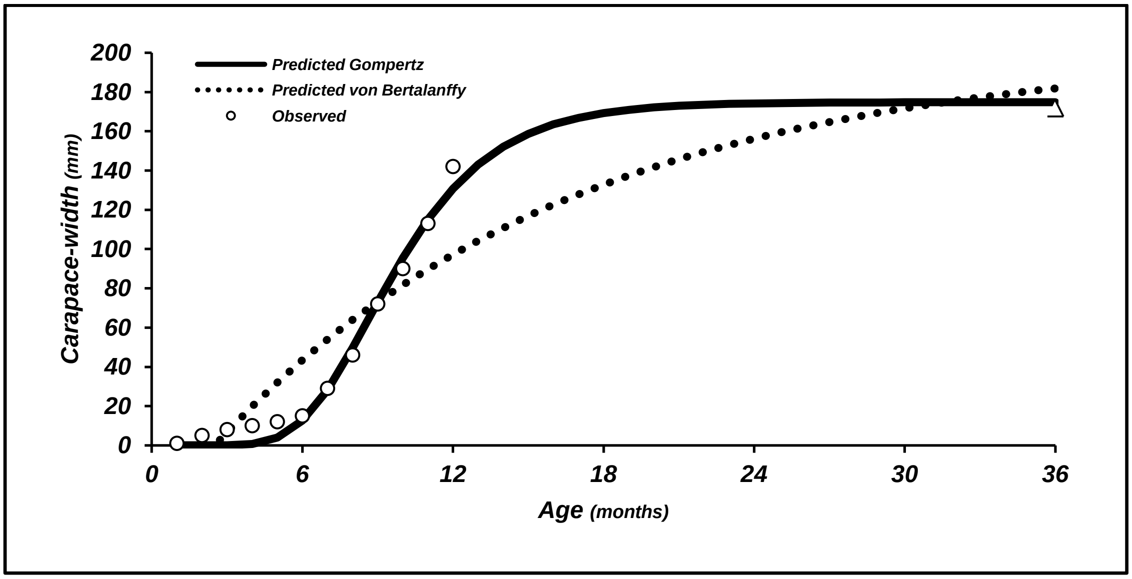


Figure 6: Size-at-age of blue crab *Callinectes sapidus*. Seasonal size-at-age (Jan-Apr, May-Aug, and Sep-Dec) is estimated from Gompertz growth models. The horizontal dashed line represents the minimum size limit of the fishery. The vertical dashed line represents the beginning of the next survey year.

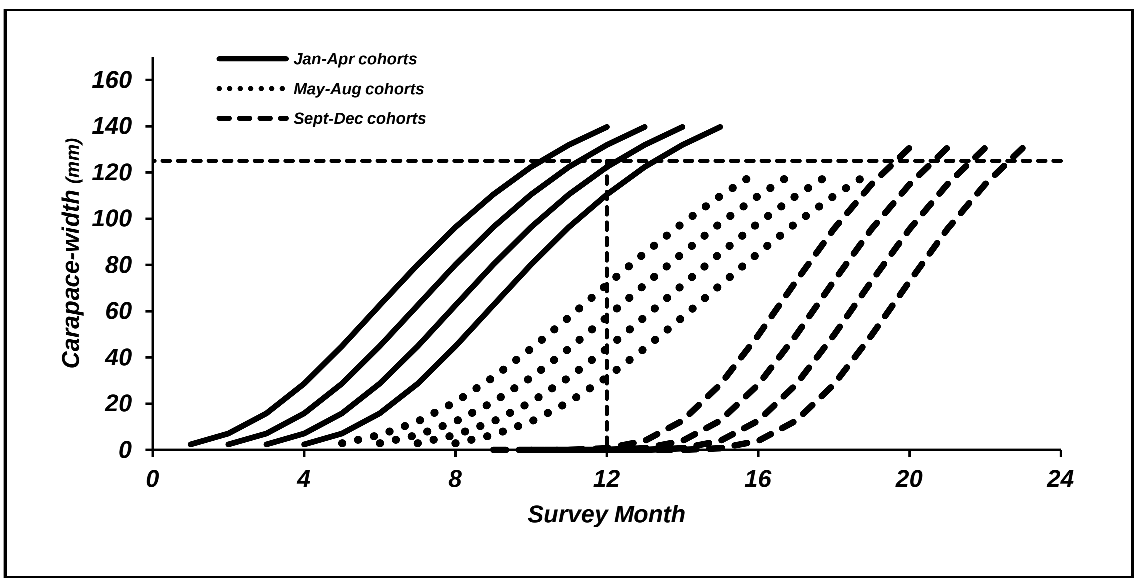
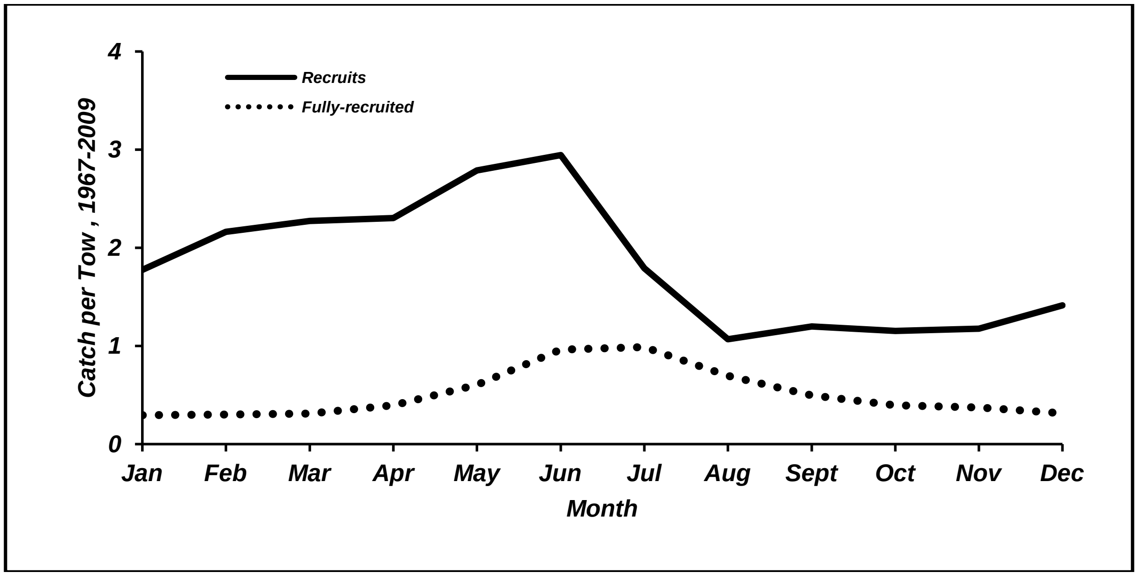


Figure 7: Monthly catch-per-unit-effort of fully-recruited, recruits, and pre-recruit Louisiana blue crab *Callinectes sapidus.* Abundance indices are derived as the delta-lognormal mean catch-per-tow from the LDWF fishery-independent trawl survey, 1967-2009. Top graphic illustrates not accounting for pre-recruits or the crabs that will not recruit to the fishery during the survey year. Bottom graphic illustrates accounting for pre-recruits.



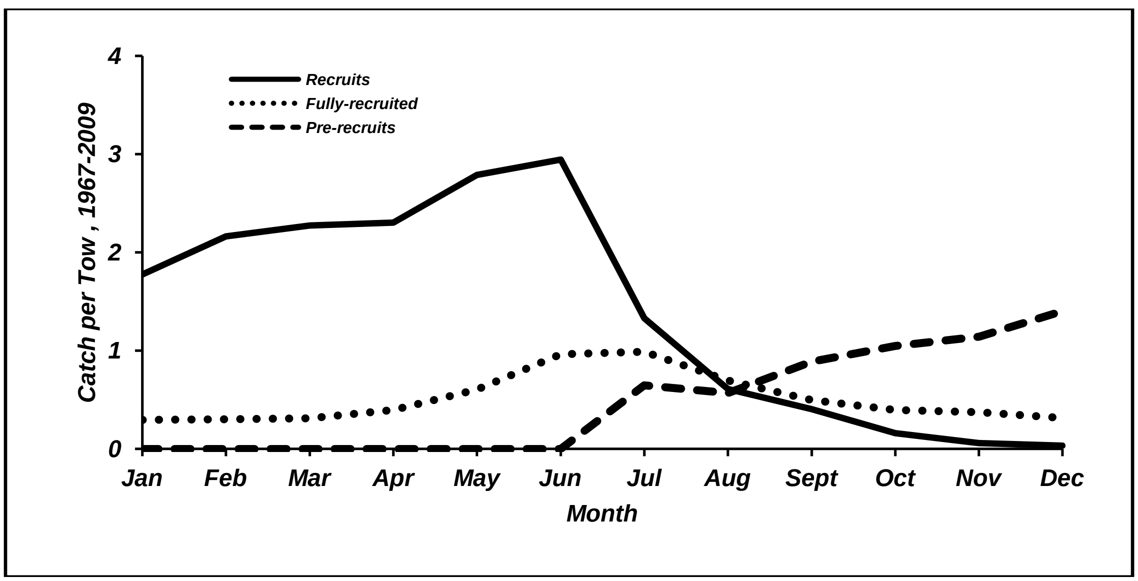
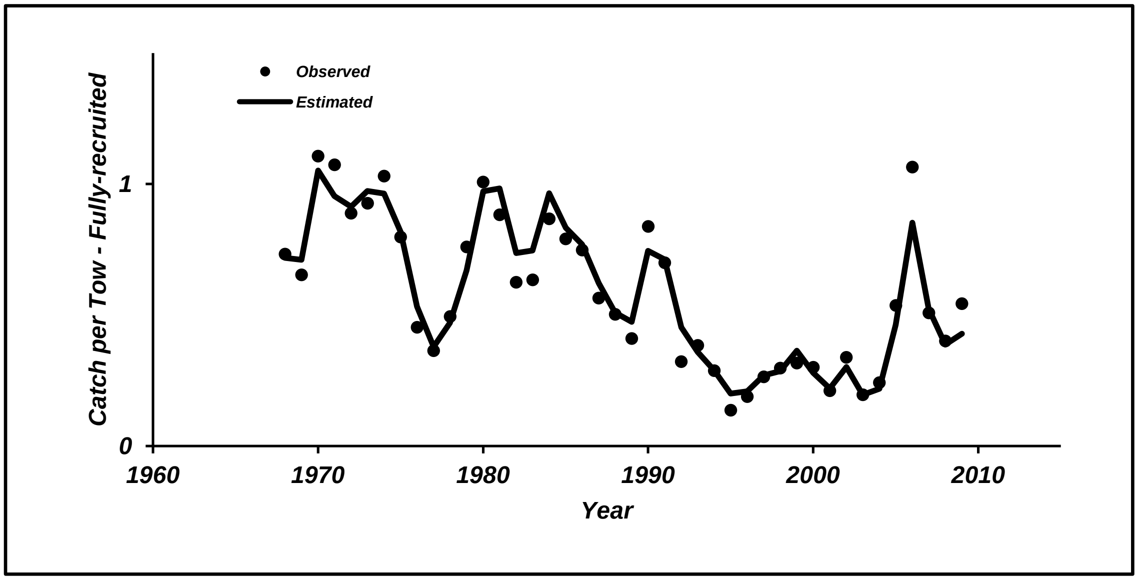


Figure 8: Catch-per-unit-effort of fully-recruited Louisiana blue crab *Callinectes sapidus.* Predicted index is derived from lognormal observation error of the catch-survey model. Nominal index is the delta-lognormal mean catch-per-tow from the LDWF fishery-independent trawl survey, 1967-2009. Bottom graphic depicts lognormal residuals or $log_e(n_y/\hat{n}_y)$ where $\hat{n}_y$ is predicted from observation error. Fully-recruited crabs are $\geq 125mm$ carapace-width.



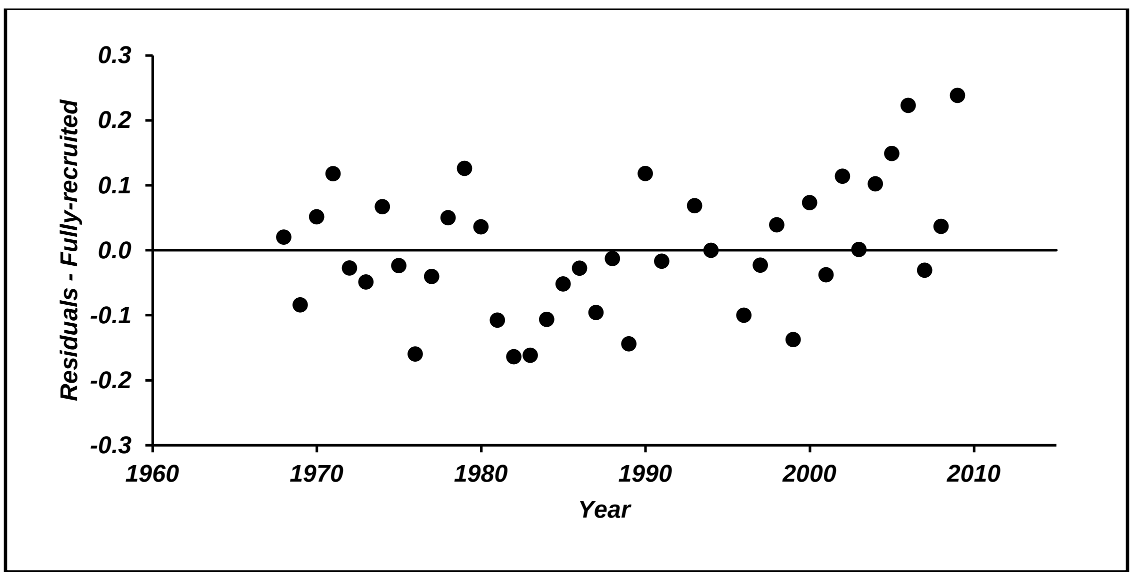
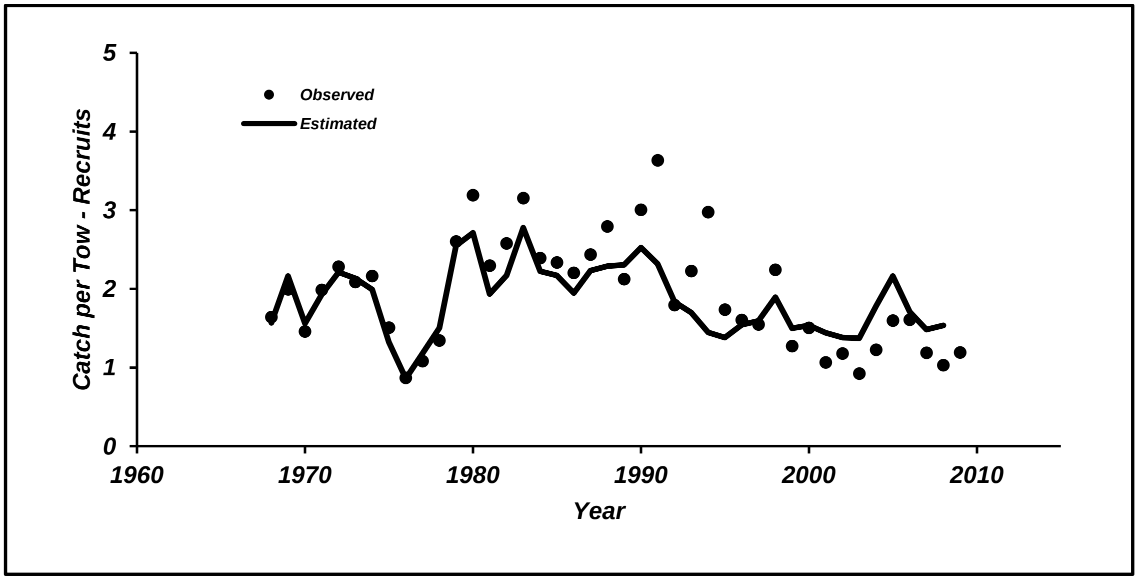


Figure 9: Catch-per-unit-effort of Louisiana blue crab *Callinectes sapidus* recruits. Predicted index is derived from lognormal observation error of the catch-survey model. Nominal index is the delta-lognormal mean catch-per-tow from the LDWF fishery-independent trawl survey, 1967-2009. Bottom graphic depicts lognormal residuals or $log_e(r_y/\hat{r}_y)$ where $\hat{r}_y$ is predicted from observation error. Recruits are crabs $\geq 25mm$ and $< 125mm$ carapace-width.



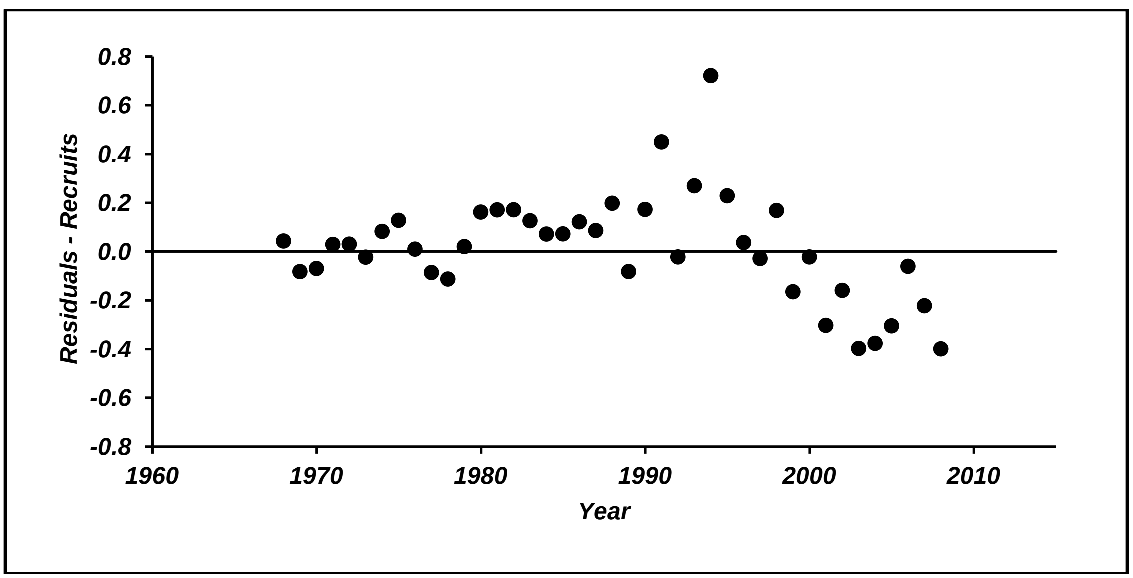
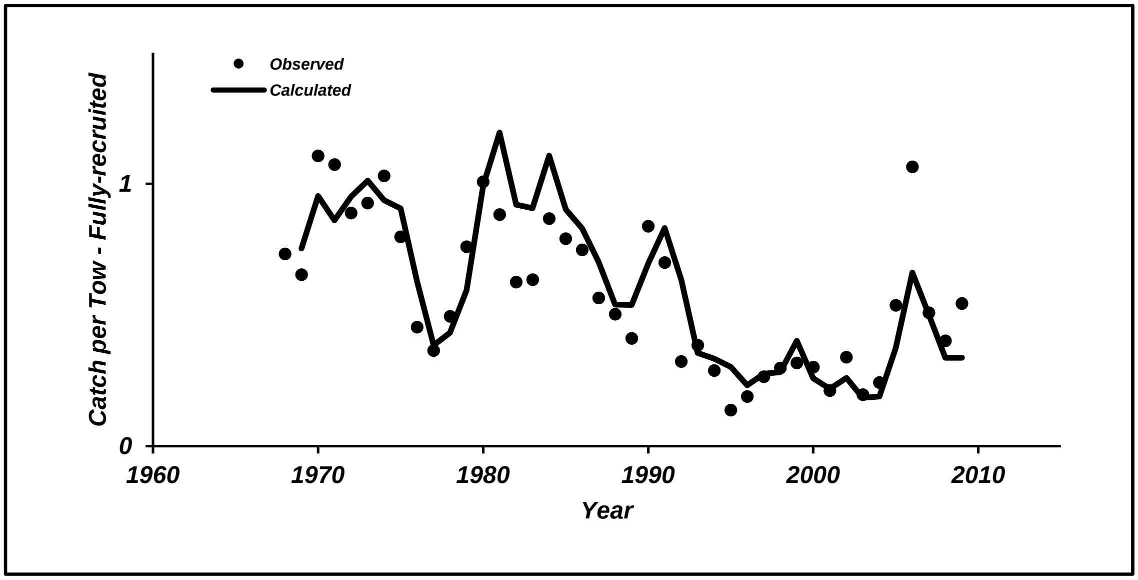


Figure 10: Catch-per-unit-effort of fully-recruited Louisiana blue crab *Callinectes sapidus.* Calculated index is derived from lognormal process error of the catch-survey model. Nominal index is the delta-lognormal mean catch-per-tow from the LDWF fishery-independent trawl survey, 1967-2009. Bottom graphic depicts lognormal residuals or $log_e(n_y/\hat{n}_y)$ where $\hat{n}_y$ is calculated from process error. Fully-recruited crabs are $\geq 125mm$ carapace-width.



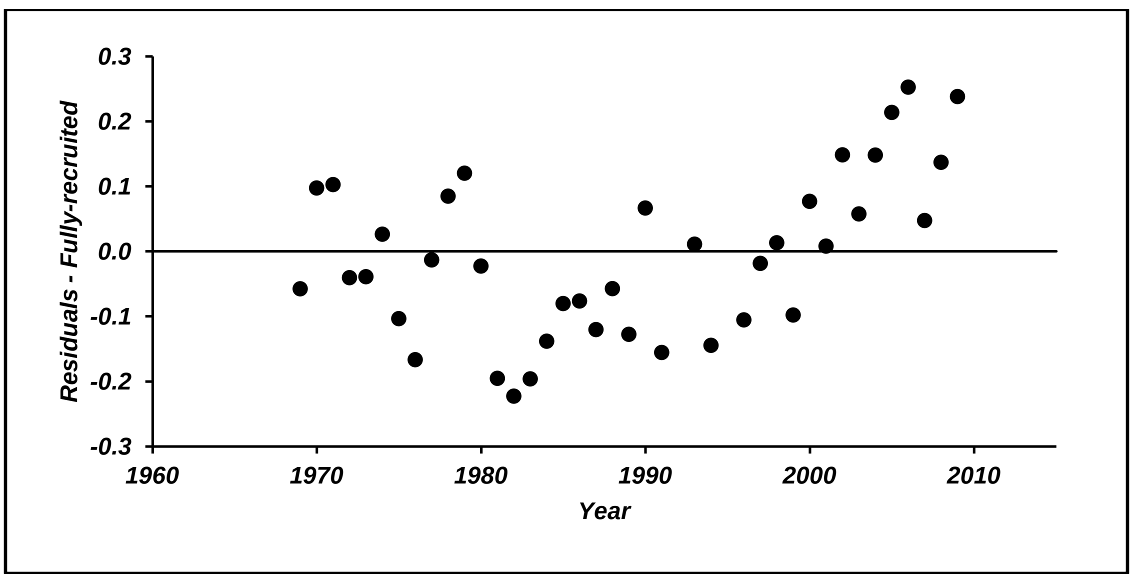


Figure 11: Biomass of Louisiana blue crab *Callinectes sapidus* derived from the catch-survey model. Units are millions of pounds. Recruits are crabs $\geq 25mm$ and $< 125mm$ carapace width. Fully-recruited crabs are $\geq 125mm$ carapace width.

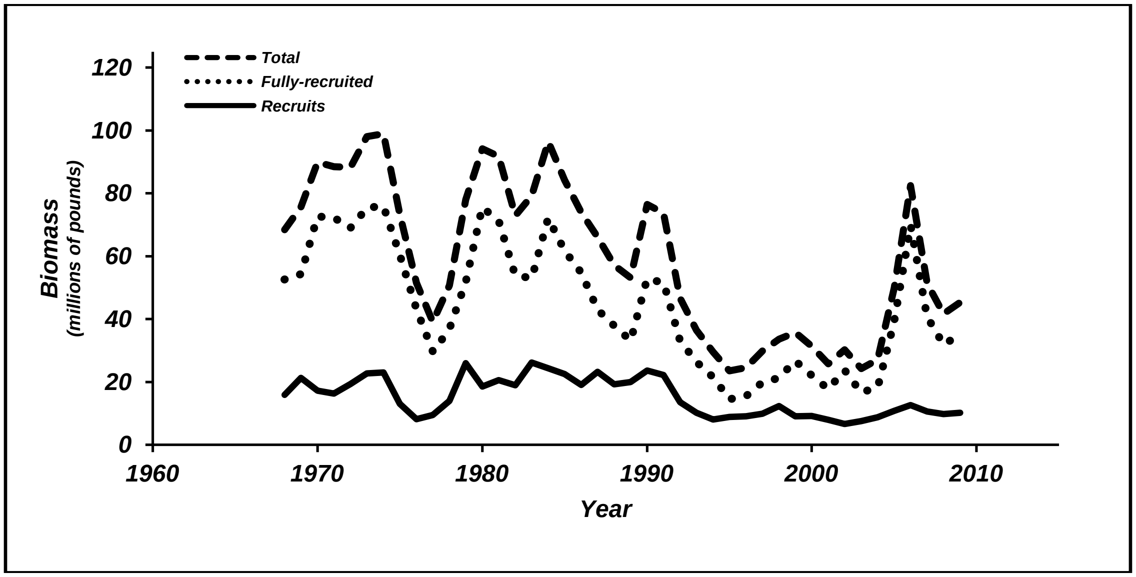


Figure 12: Abundance of Louisiana blue crab *Callinectes sapidus* derived from the catch-survey model. Units are millions of individuals. Recruits are crabs $\geq 25mm$ and $< 125mm$ carapace width. Fully-recruited crabs are $\geq 125mm$ carapace width.

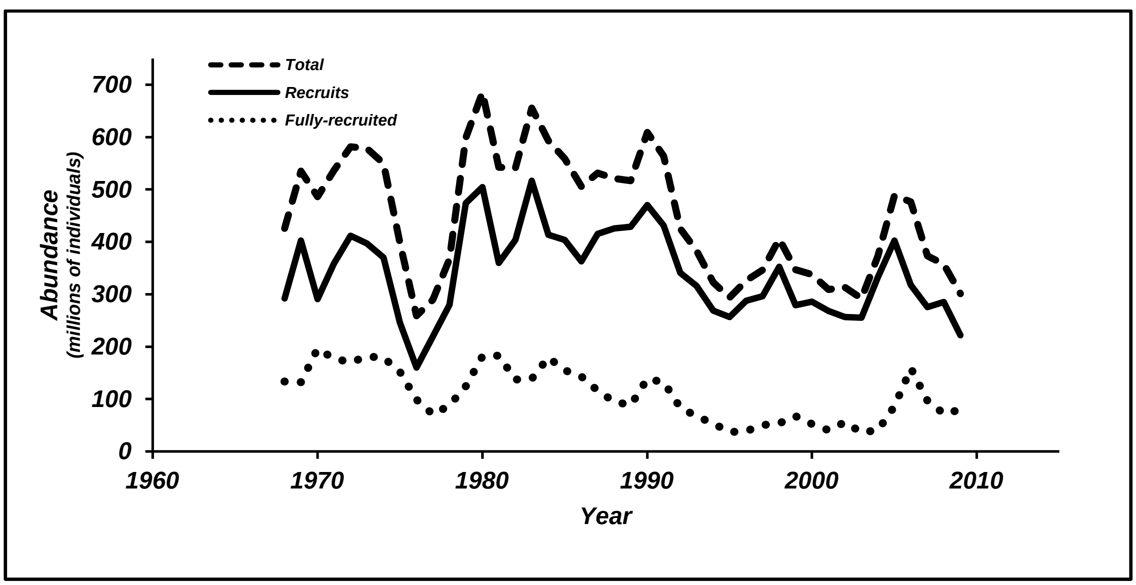


Figure 13: Fully-recruited abundance and harvest of Louisiana blue crab *Callinectes sapidus*. Abundance is derived from the catch-survey model. Commercial hard crab landings are expanded by 5% to approximate for recreational harvest. Units are millions of individuals.

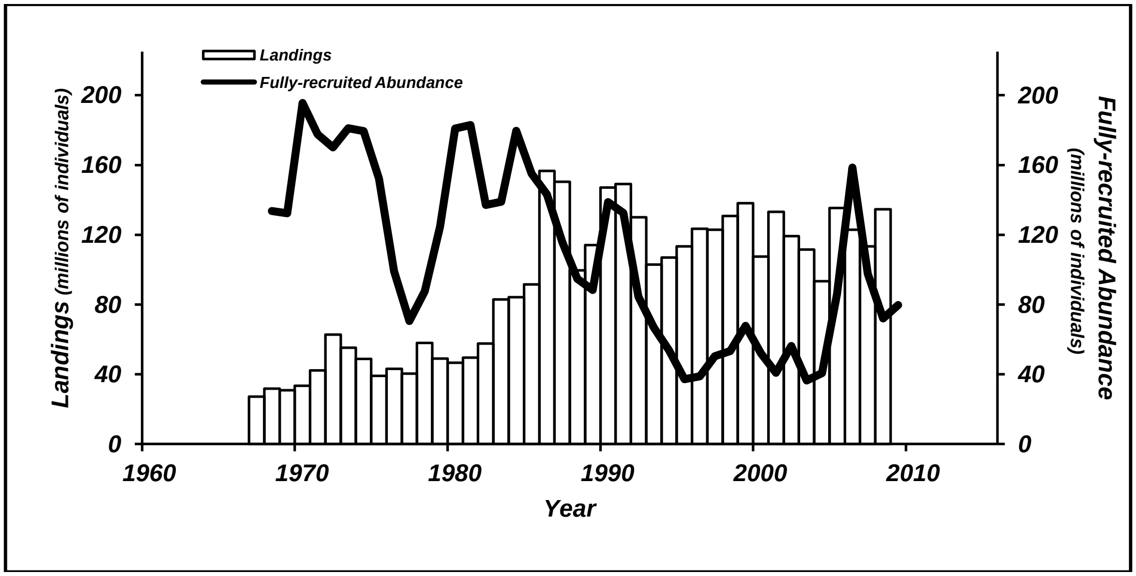


Figure 14: Exploitable biomass and subsequent recruitment of Louisiana blue crab *Callinectes sapidus*. Estimates are derived from the catch-survey model. Recruits are crabs $\geq 25mm$ and $< 125mm$ carapace width. Fully-recruited crabs are $\geq 125mm$ carapace width. Abundance units are millions of individuals. Biomass units are millions of pounds. The diamond represents the most current data pair.

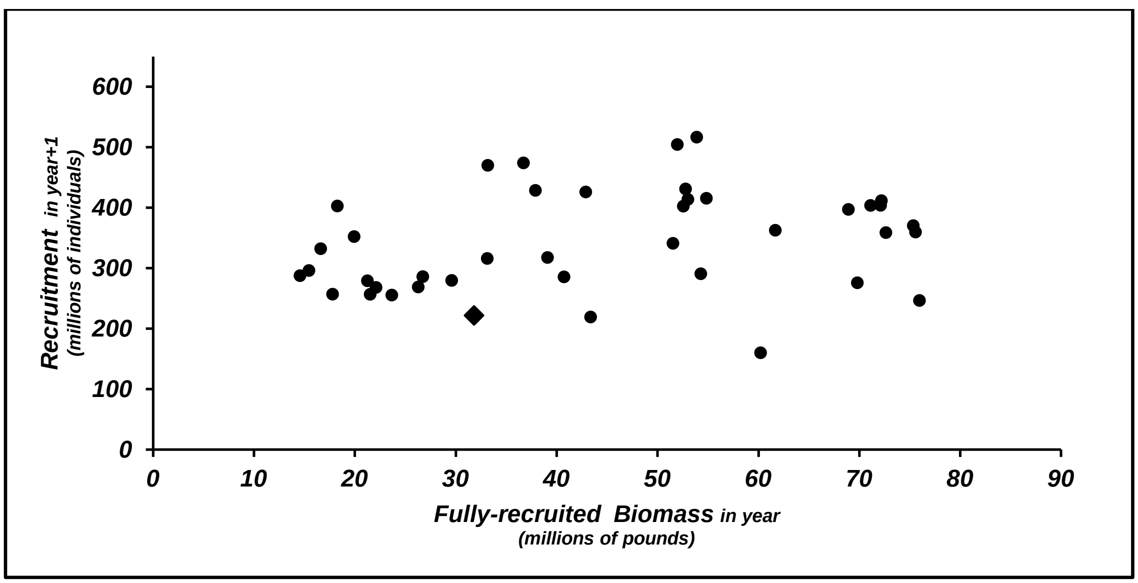


Figure 15: Fishing mortality and directed effort for Louisiana blue crab *Callinectes sapidus*. Fishing mortality, 1968-2008, is estimated from the catch-survey model. Fishing effort, 1999-2009, is trap fisher trips per year taken from the LDWF Trip Ticket Program. Fishing effort is not used in the assessment model, but is presented to validate trends in fishing mortality estimates. Fishing effort is thousands of trap fisher trips.

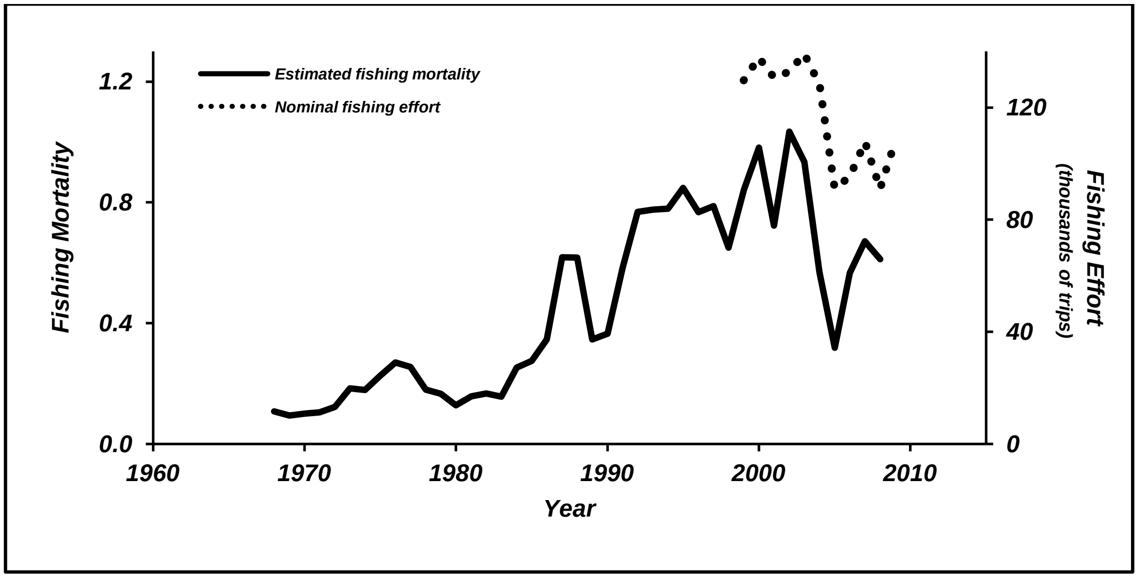


Figure 16: Sensitivity analysis of recruit abundance of Louisiana blue crab *Callinectes sapidus* to different assumptions of instantaneous natural mortality ($M = 0.8, 1.0, 1.2$). Recruit abundance, 1968-2009, is estimated from the catch-survey model. Units are millions of individuals.

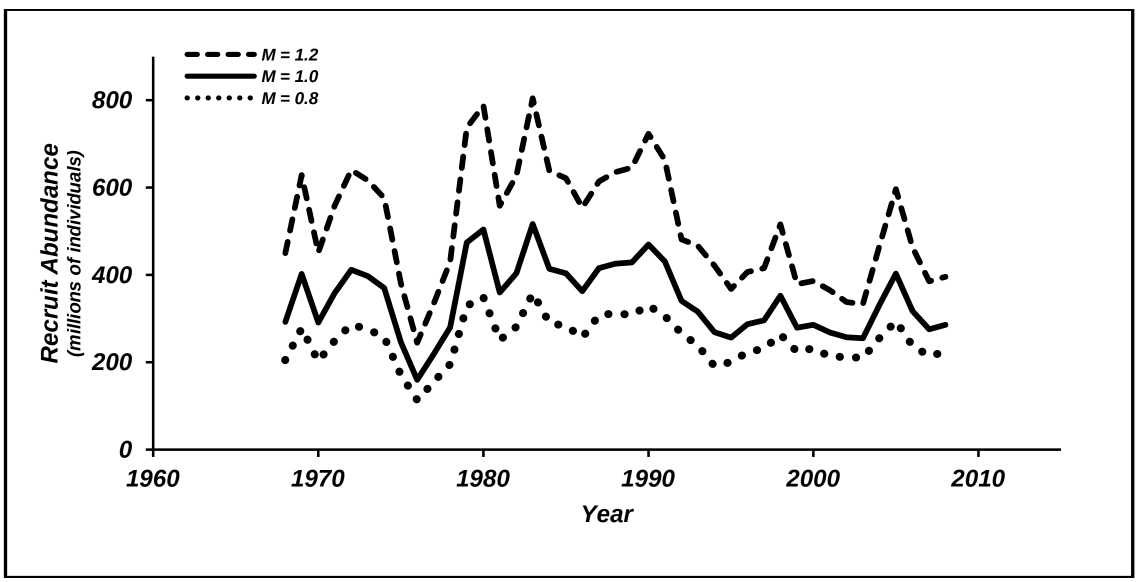


Figure 17: Sensitivity analysis of fully-recruited abundance of Louisiana blue crab *Callinectes sapidus* to different assumptions of instantaneous natural mortality ($M = 0.8$, 1.0, 1.2). Fully-recruited abundance, 1968-2009, is estimated from the catch-survey model. Units are millions of individuals.

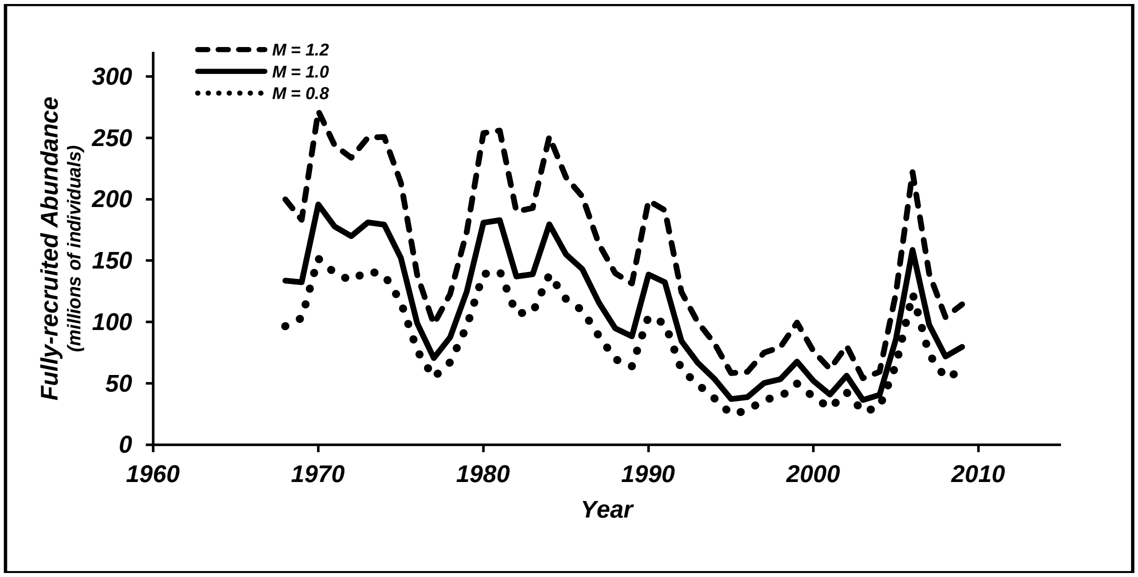


Figure 18: Sensitivity analysis of instantaneous fishing mortality of Louisiana blue crab *Callinectes sapidus* to different assumptions of instantaneous natural mortality ($M = 0.8$, 1.0, 1.2). Fishing mortality, 1968-2008, is estimated from the catch-survey model.

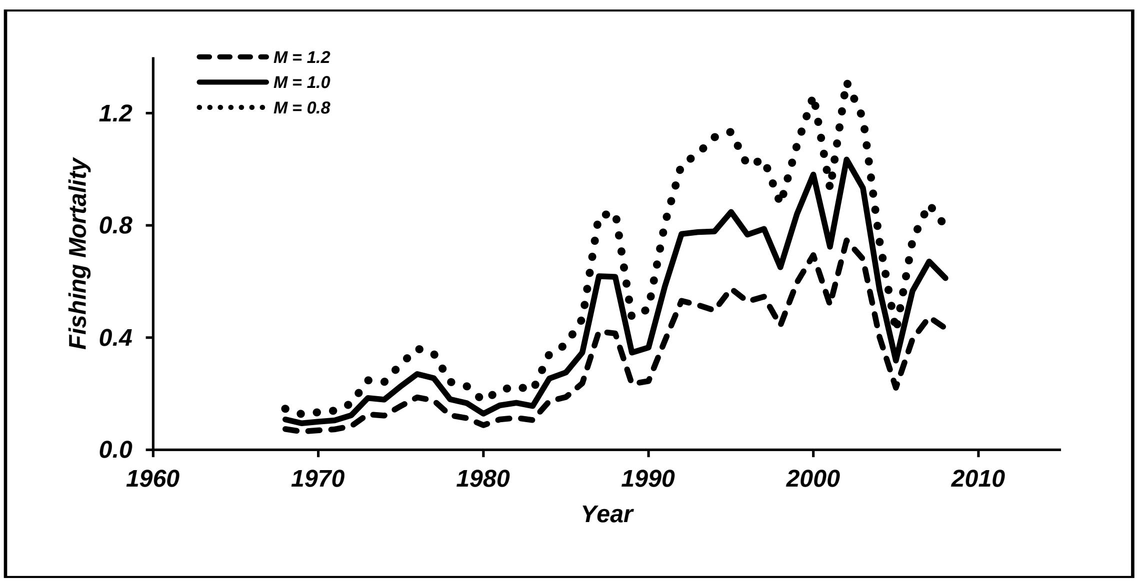


Figure 19: Equilibrium recruitment (represented by the horizontal line) and the fished and unfished estimates of recruitment per spawner (represented by the slopes of the diagonal lines) corresponding with $17.6,\ 26.4$, and $100\%\ SPR's$. Exploitable biomass and subsequent recruitment of Louisiana blue crab *Callinectes sapidus* are derived from the catch-survey model. Recruits are crabs $\geq 25mm$ and $< 125mm$ carapace width. Fully-recruited crabs are $\geq 125mm$ carapace width. Abundance units are millions of individuals. Biomass units are millions of pounds. The diamond represents the most current data pair. The triangle represents the 2009 biomass estimate.

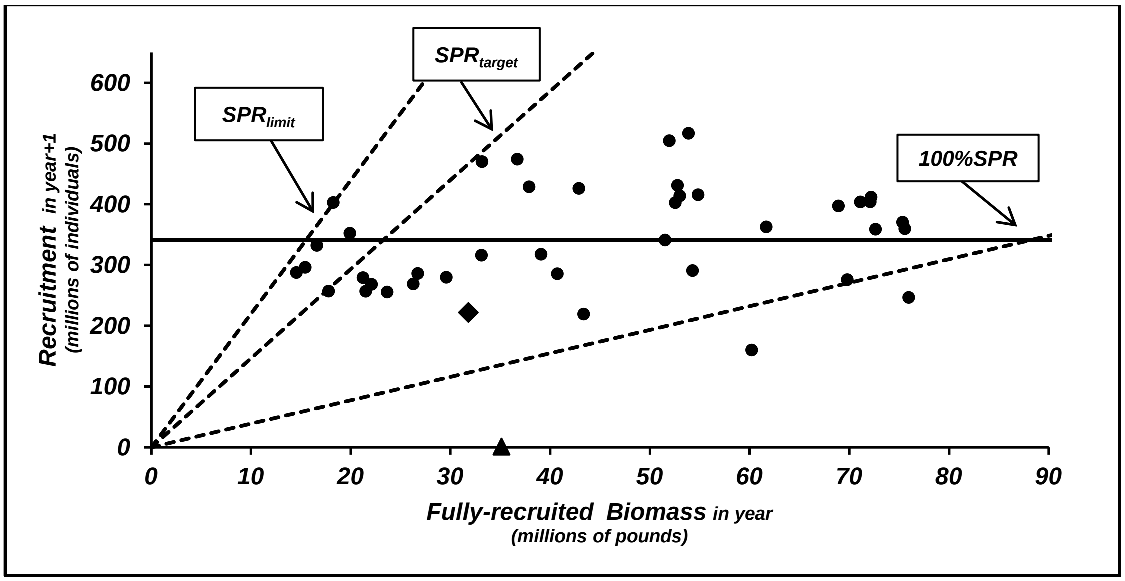
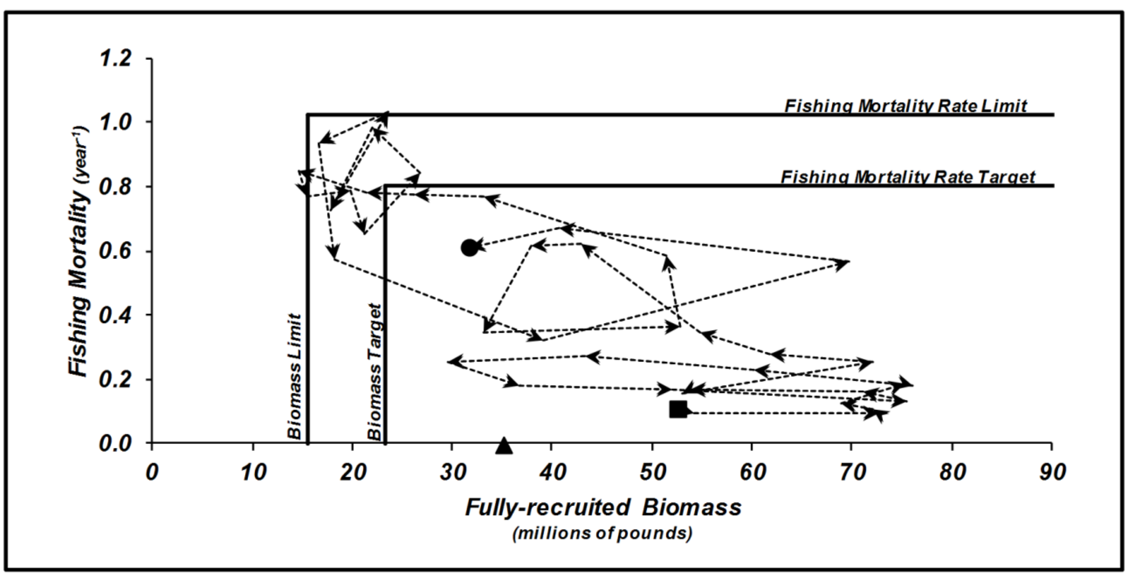


Figure 20: Biological reference points for the Louisiana blue crab *Callinectes sapidus* stock. Fully-recruited biomass and instantaneous fishing mortality are estimated from the catch-survey model. The biomass limit and target are represented by the solid vertical lines. The fishing mortality rate limit and target are represented by the solid horizontal lines. The square represents the first year of data pairs and the circle represents the last. The triangle represents the 2009 biomass estimate. Biomass units are millions of pounds. Fishing mortality rate units are $years^{-1}$.



11. Appendix – Regulation Summary

The Louisiana blue crab fishery and its industry is governed by the State of Louisiana legislative, the Department of Wildlife and Fisheries and the Wildlife and Fisheries Commission. Specific regulations are grouped by category in the following paragraphs along with any recommended changes and/or considerations. This summary should be used as a digest only, not as a valid compilation for legal purposes, because exact languages have not have been retained. Legislative rules and statutory authorities that are delegated to the Commission and Department are contained in Louisiana Revised Statutes Title 56 (R.S. 56), while regulations of the Wildlife and Fisheries Commission and the Department of Wildlife and Fisheries are contained in Louisiana Administrative Code Title 76 (LAC 76).

11.1 Statutory Authority

The Commission may: (a) promulgate regulations to set seasons, times, places, size limits, quotas, daily take, and possession limits for all fish, with any present statutory rule or regulation being superseded (R.S. 56:5); (b) prohibit the taking of any species of fish in any part of the state for not more than a three-year period if it is in the best interests of the state (R.S. 56:22); and, (c) set aside sanctuaries for the protection and propagation of fish and may restrict fishing (R.S. 56:315).

The Secretary may: (a) grant written permits to other persons to take fish of any kind in any manner or place for the purpose of cultivation (R.S. 56:17); (b) declare a closed season, or restrict fishing in the closed season, for any species of fish, upon receiving evidence that fish in any waters of the state have been depleted through overfishing, or that fishing is detrimental to the interests of the state (R.S. 56:317); (c) issue permits for propagation or for distribution (R.S. 56:318) or to develop new fisheries designed to harvest underutilized species and to develop new gear and equipment to harvest fish (R.S. 56:571); and, (d) set seasons, regulate the type of gear used, and set possession limits for estuarine fish where it is clearly demonstrated that intense competition exists or if pollution levels exceed accepted standards or if biological studies indicate the need (R.S. 56:327(E).

11.2 Gear Restrictions

Crabs may be taken with any legal crab trap, crab dropnet, trawl, trotline, handline, bushline, dip net, cast net, seine, trammel net, or gill net. R.S. 56:320(B)(3)

Dredges cannot be used for the intentional taking of crabs. R.S. 56:332(A).

Crabs of legal size may be taken using any gear identified in R.S. 56:320(B)(3); however, harvest of crabs by trawls in inside waters is permitted only during the open season for shrimp and with a legal commercial mesh size.

A trotline cannot be set above the water surface. R.S. 56:321

In private artificial earthen reservoirs crabs of any species may be harvested with seines or tackle selected by the owner. R.S. 56:551

"Crab dropnet" means any device constructed with vegetable, synthetic or metal fibers and without flues or throat, attached to a wire frame that forms a net basket and is used for the purpose of taking crabs. This device must be operated solely by hand and fished in a stationary, passive manner. R.S. 56:8(34)

"Crab trap" means a cube-shaped device with entrance funnels and either a bait box or materials providing cover or shelter for peeler crabs, which is used for the sole purpose of taking crabs. This device must be fished in a stationary, passive manner. R.S. 56:8(35)(a)

"Trotline" means any set line less than 440 yards long with hoop drops tied at various intervals. R.S. 56:8(140)

Each crab trap shall be marked with a 1/2 inch stainless steel self-locking tag containing the commercial fishermen's license number or recreational trap gear license number attached to the center of the trap ceiling or durable bait box cover. R.S. 56:332(D) and LAC 76:VII.345(A)

Each crab trap shall have a minimum of two escape rings which shall be placed on the vertical, outside walls flush with the trap floor or baffle, with at least one ring located in each chamber of the trap. Minimum ring size shall be two and five-sixteenths inches in inside diameter, not including the ring material. The rings shall be rigid and attached to the trap with material of a smaller diameter than the wire strands of the trap. Except from April 1st through June 30th and from September 1st through October 31st, escape ring openings shall not be obstructed with any material that prevents or hampers exit of crabs. However, the use of rings shall not apply to those crab traps placed in Lake Pontchartrain. R.S.56:332(K)

Crab traps located in areas designated as freshwater north of the northern bank of the Intracoastal Waterway and west of Louisiana Highway 70 are not required to be marked with a float and float line and those areas located on the eastern side of the Mississippi River and inland from the saltwater line are not required to be marked with a float and float line, unless the trap is placed in a lake. R.S. 56:320(B)3

11.3 Size Limits

Any blue crab under the minimum prescribed size must be returned immediately to the waters from which taken without avoidable injury. Blue crabs under the legal size may be taken from privately owned ponds, impoundments, or waters and sold to other persons for purposes of stocking private waters, ponds, or impoundments. R.S. 56:326(A)

The size limit on hard-shell commercial crabs is five inches in carapace width, except when held for later processing as soft crabs. R.S.56:326(A)(1)

Premolt crabs less than five inches in width held by a fishermen for later processing as softshell crabs must be identifiable as pre-molt crabs and must be held in a separate container marked "peelers" or "busters". Pre-molt "buster" or "peeler" stage crabs must be no further from molting than having a white line on the back paddle fin. R.S.56:326(A)(2)

If more that 10 percent of crabs in a fifty crab random sample are less than the minimum size limit, the entire number of crabs in that crate or group of crabs equivalent to one crate is in violation. However, 5%

of the total number of crabs in possession may be smaller than the legal limit. R.S. 56:326(B)(1) and (B)(2)

Crabs held in a work box shall not be subject to minimum size limits while held only onboard a vessel. Commercial fishermen may possess either one work box, if not using a grader, or two work boxes under the grader, if using a grader. R.S.56:326(B)(4)

Wholesale/retail seafood dealers, retail seafood dealers and commercial fishermen may be subject to penalties for possession of undersized crabs. If the wholesale or retail dealer can identify the commercial fisherman, only the latter is subject to undersize crab violations. R.S. 56:326(F)(1)(a)

11.4 Seasons

No seasons are established in statute or rule, however, the Wildlife and Fisheries Commission has established a program to remove abandoned crab traps from state-owned lake and river beds and other water bottoms of the state. The commission may prohibit the use of crab traps in one or more geographical areas of the state during a maximum sixteen-consecutive-day period between February 1st and March 31st and during a maximum fourteen-consecutive-day period of time which includes the opening day of the spring inshore shrimp season. R.S.56:332(N)

11.5 Time Restrictions

The baiting, tending, checking, or removing of crab traps, the contents of crab traps or their lines, buoys, or markers is prohibited in public waters from one-half hour after sunset until one-half hour before sunrise. R.S. 56:332(C)(1)

Crab traps which are no longer serviceable or in use must be removed from the water. R.S. 56:332(E)(1)

11.6 Area Restrictions

Crab traps cannot be set in navigable channels or entrances to streams and the crab fisherman is responsible for placing his traps so vessels can safely navigate. R.S. 56:332(G)

The taking of crabs with legal crab traps, crab pots, nets, and lines shall be permitted in the Lake Catherine and Lake Pontchartrain Sanctuary. R.S. 56:332(I)

Metal tackle or metal crab traps shall not be used in any of the public waters north of the Intracoastal Canal in the Calcasieu River or in any body of water comprising the Calcasieu River System north of the Intracoastal Canal, or in the waters of Vermilion Bay from Cypremort Point one mile offshore to Blue Point. R.S. 56:332(J).

The use of seine, nets, webbing or traps of any and all types is prohibited in the Tchefuncte River. R.S. 56:405(A)

Commercial crabbing is prohibited on the following wildlife management areas or refuges: Rockefeller Wildlife Refuge (LAC 76:I.309), Marsh Island Wildlife Refuge (76:I.310), Pointe au Chene Wildlife

Management Area except for the Cut-Off Canal and Wonder Lake (76:XIX.111(G), and Salvador Wildlife Management Area (76:XIX.111(G)).

11.7 Bag and Possession Limits

Blue crabs of legal size may be taken in unlimited quantities, provided there is compliance with all other requirements of the law. R.S. 56:326(A).

11.8 Other Restrictions

Commercial fisher's must tag, mark or otherwise identify any crabs sold with the commercial fisher's license number, name, and date harvested. R.S. 56:326(F)2

No person may take diamondback terrapin by traps of any kind. R.S. 56:635(A)

No person can keep or sell adult female crabs in the berry, or egg, stage. All crabs in the berry stage taken by any means must be returned immediately to the waters. R.S. 56:332(B)

No person may intentionally damage or destroy crab traps, floats or lines, or remove the contents thereof, other than the licensee or his agent. R.S. 56:332(E)1

The harvesting of any fish for commercial purposes which results in the excessive killing of such fish ("wasting" of fish) is prohibited. R.S. 56:409.1(A)

A licensed commercial fisher may retain for personal consumption finfish caught as by-catch in crab traps up to an aggregate of twenty-five finfish per vessel per day. However, no game fish or spotted sea trout may be kept as a part of the aggregate and any fish kept are subject to statutory and regulatory size and possession limits applicable to recreational fishing. In addition to any fish retained as by-catch, any licensed commercial fisherman holding a crab trap license which allows him to take finfish for commercial purposes may possess any finfish caught under that gear license up to the commercial possession limit allowable for such finfish and such finfish shall not be required to be segregated from the recreational by-catch allowed. R.S.56:332 (M)(1) and (M)(2)

11.9 Licensing Requirements

Commercial Fisherman's License

- A commercial fisher taking crabs for sale must purchase a commercial fisher's license. R.S.56:303(A)1
- Cost is $55 for residents and $460 for non residents R.S.56:303(B)
- Valid for one year beginning January 1st and ending December 31st R.S.56:303.1(A)
- Available for purchase at any time of the year for the current license year and from November 15th for the immediately following license year. R.S.56:303.1(B)
- A commercial fisher holding a commercial fisher's license may transport and sell his own catch to any licensed Louisiana wholesale/retail seafood dealer located within the state of Louisiana. R.S.56:303.7(A)

- Holder of a commercial fisher's license who sells or transfers his catch to a wholesale/retail seafood dealer must present his license to the dealer for verification and provide the dealer with the necessary information needed to complete trip tickets LA R.S.56:303.7(B)
- Unlawful for the owner of a commercial fishing vessel to allow any person who does not hold a commercial fisherman's license to operate the vessel while commercial fishing or in possession of crabs for sale while on the water. R.S.56:304.2(A)
- Senior Commercial Fisherman's license available to residents 70 years of age or older at a cost of $20 and also serves in lieu of any required commercial gear licenses. R.S.56:303 (F)
- Certified Commercial Fisherman's license available upon presentation to LDWF of a notarized statement from the tax preparer certifying that based upon his most recent tax return the individual earns at least 50% of his income from commercial fishing activities. R.S.56:303(E)1

Fresh Products License

- A commercial fisherman selling his catch directly to a consumer must possess a fresh products license. R.S.56:303(A)2 and R.S.56:303.1.1(A)
- A commercial fisherman may purchase a secondary fresh products license for a spouse at a cost of $5. R.S.56:303.1.1(E).
- The cost of a fresh products license shall be $20 for residents and $120 for nonresidents. The fresh products license shall be valid for one year, beginning on January 1st of each calendar year and expiring on December 31st of the same calendar year. R.S.56:303.1.1(B)
- A commercial fisherman selling crabs under a fresh products license shall record all information required on trip tickets, except that the fresh products license number shall be recorded in place of the wholesaler/retailer seafood dealer's license number. The fresh products licensee shall complete monthly returns to the department as specified for wholesale/retail seafood dealers. The commercial fisherman shall sign each commercial receipt form attesting that the information provided therein is correct. R.S.56:303.7(C)

Gear License

- A commercial fisherman must possess a commercial gear license indicating that the applicable gear fee has been paid whenever using or possessing any gear on the fishing grounds. R.S.56:303.2(A) and R.S.56:305 (A)
- A commercial gear license can only be purchased by a person possessing a valid commercial fisherman's license. R.S.56:305.2 (A)
- A gear fee must be paid for each piece of gear or each type of gear, whichever is applicable, being used to take crabs or, if the gear is not in use but is in possession on the fishing grounds, the gear fee must be paid for each piece of gear or type of gear, whichever is applicable, intended for use or used to take fish. R.S.56:305(A) and (E)
- Cost of a crab trap license is $35 for residents and $140 for non residents. An amount equal to $5 from each resident commercial crab trap gear license shall be credited to the Derelict Crab Trap Removal Program Account as provided in R.S. 56:10(B)(13), and an amount equal to $5 from each resident commercial crab trap license shall be credited to the Crab Promotion and Marketing

Account as provided in R.S. 56:10(B)(1)(e). Any resident who holds a senior commercial fishing license shall be exempt from the provisions of this Paragraph. R.S.56:305(B)(1), (B)(11) and (B)(13)

- Licenses may be temporarily transferred between licensed commercial fishermen having the same residency status. R.S.56:305.3(A)
- Not available for sale if domiciliary state prohibits the use of similar commercial fishing gear. R.S.56:30(C)(2)
- Valid for one year beginning January 1st and ending December 31st R.S.56:305.1(A)
- Available for purchase at any time of the year for the current license year and from November 15th for the immediately following license year. R.S.56: 305.1(B)

Vessel License

- A vessel must be licensed whenever engaged in commercial fishing in or whenever possessing crabs for sale in saltwater areas of the state. R.S.56:304(A)
- Cost of the vessel license is $15 for residents and $60 for nonresidents. R.S.56:304(B)
- Issued only to the owner of the vessel R.S.56:304(D)
- Valid for one year beginning January 1st and ending December 31st. R.S.56:304.1(A)
- Available for purchase at any time of the year for the current license year and from October 15th for the immediately following license year. R.S.56:304.1(B)
- Are not transferable and the name of a vessel for which a vessel license has been issued cannot be changed without prior notification to the department. R.S.56:304.5(A) and (B)

Wholesale/Retail Seafood Dealer's License

- Any person buying, acquiring, or handling, from any person, by any means whatsoever, any species of crab, whether fresh, frozen, processed, or unprocessed, in Louisiana from within or outside the state, for sale or resale, including bait species, whether on a commission basis or otherwise, must possess a wholesale/retail seafood dealer's license. R.S.56:306 (A)(1)
- The owner or operator of any soft shell crab shedding facility, or other processing plant shall have a wholesale/retail seafood dealer license. R.S.56:306(A)(2)(a)
- If the place of business is a vehicle, the license shall state "vehicle" and shall list the legal mailing address and physical location of the licensee. R.S.56:306(B)(1)
- Any person shipping crabs into or out of the state shall possess wholesale/retail seafood dealer's license. R.S.56:306(A)(2)(b)
- A wholesale/retail seafood dealer's license is required for each place of business. R.S.56:306(B)3
- Must operate from the physical location of the business except for a wholesale/retail seafood dealer's license issued to a vehicle. R.S.56:306(B)(1)
- A commercial fisherman selling his catch to anyone or any business other than a consumer or licensed wholesale/retail seafood dealer must possess a wholesale/retail seafood dealer's license. R.S.56:303(A)(2)
- The cost of the wholesale/retail seafood dealer's license is $250 for residents and $1,105 dollars for nonresidents. R.S.56:306.2(A)(1)

- The license shall be valid for one year, beginning on January 1st of each calendar year and expiring on December 31st of the same calendar year. R.S.56:306.3(A)
- The license may be purchased at any time of the year for the current license year and from October 1st for the immediately following license year. R.S.56:306.3(B)

Out of State Crab Shipping License

- Any wholesale/retail seafood dealer who exports or attempts to export outside of Louisiana any crabs, soft shell crabs, boiled crabs, containerized crabmeat, or containerized pasteurized crab meat shall purchase an out-of-state crab shipping license. Fee is $100. R.S.56:306.1(B)(6)(a)
- The license shall be valid for one year, beginning on January 1st of each calendar year and expiring on December 31st of the same calendar year. The license may be purchased at any time of the year for the current license year and from November 15th for the immediately following license year. R.S.56:306.1(B)6(b)

Retail Seafood Dealer License

- Any person buying, acquiring, or handling by any means whatsoever, from a Louisiana wholesale/retail seafood dealer, any species of crabs whether fresh, frozen, processed, or unprocessed, that sells to the consumer for personal or household use and any person who ships fish out of or within the state of Louisiana to the consumer for personal or household use shall purchase a retail seafood dealer's license. R.S.56:306.1(A)
- A retail seafood dealer's license is required for each place of business. R.S.56:306.1(B)(3)
- Must operate from the physical location of the business except for a retail seafood dealer's license issued to a vehicle. R.S.56:306.1(B)(1)
- Retail seafood dealers, restaurants and retail grocers shall buy directly only from wholesale/retail seafood dealers licensed in Louisiana. R.S.56:306.4(C)(1)
- If the place of business is a vehicle, the license shall state "vehicle" and shall list the legal mailing address and physical location of the licensee. R.S.56:306.1(B)(1)
- Restaurants and retail grocers who only purchase crabs, whether fresh, frozen, processed, or unprocessed, from a licensed wholesale/retail seafood dealer and only sell such crabs fully prepared by cooking for immediate consumption by the consumer need not be licensed. R.S.56:306.1(B)(6)
- The cost of the retail seafood dealer's license is $105 for residents and $405 for nonresidents. R.S.56:306.2(A)(2)
- A retail seafood dealer's license is valid for one year, beginning on January first of each calendar year and expiring on December 31st of the same calendar year. R.S.56:306.3(A)
- A retail seafood dealer's license may be purchased at any time of the year for the current license year and from October 1st for the immediately following license year. R.S.56:306.3(B)

Seafood Transport License

- Operators and drivers of any form of commercial transport, except common carriers, who are in the act of loading, unloading, or transporting crabs shall have in their possession at least a commercial fisherman's license or wholesale/retail dealer's license or transport license. R.S.56:307(A)

- In lieu of a wholesale/retail seafood dealer or retail seafood dealer license, a seafood transport license is required for each vehicle when delivering for or on behalf of a wholesale/retail seafood dealer or retail seafood dealer. R.S.56:306(B)(4) and R.S.56:306.1(B)(4)
- No license required to transport processed crabs or crab products. R.S.56:307(C)
- Issued in the name of the wholesale/retail seafood dealer or retail seafood dealer licensee. R.S.56:307.1(B)
- Remain transferable between vehicles. R.S.56:307.5
- Employees of a wholesale/retail seafood dealer or retail seafood dealer operating under authority of a transport license for the dealer, the wholesale/retail seafood dealer or retail seafood dealer remains responsible for all activities taking place under authority of that license. R.S.56:306(B)(4)
- The cost of a transport license is $30 per vehicle and can only be purchased by a person holding a valid Louisiana commercial fisherman's license or valid Louisiana wholesale/retail dealer's license. R.S.56:307.1(A)
- If a restaurant or retail grocer buys crabs from an out-of-state seller and brings crabs into the state, the restaurant or retail grocer must possess a transport license when bringing such crabs into the state. R.S.56:306.4(C)(1)

Commercial Fisherman Transport License

- A licensed commercial fisherman who possesses a commercial fisherman transport license in his name may allow other individuals to transport his catch, provided these individuals are in possession of the fisherman’s transport license.
- The transport license must be issued in the name of the commercial fisherman whose catch is being transported.

License and Residency Eligibility

"Bona fide resident" means any person who is a United States citizen or resident alien and has resided in this state continuously during the twelve months immediately prior to the date on which he applies for any license and who has manifested his intent to remain in this state by establishing Louisiana as his legal domicile, as demonstrated by compliance with all of the following, as applicable: R.S.56:8(16)

- If registered to vote, he is registered to vote in Louisiana.
- If licensed to drive a motor vehicle, he is in possession of a Louisiana driver's license, or, if over the age of fifteen years and not licensed to drive, he is in possession of a special identification card issued by the Department of Public Safety and Corrections under the provisions of R.S. 40:1321.
- If owning a motor vehicle located within Louisiana, he is in possession of a Louisiana registration for that vehicle.

- If earning an income, he has filed a Louisiana state income tax return and has complied with state income tax laws and regulations.

As to a corporation or other legal entity, a resident shall be any which is incorporated or otherwise organized under and subject to the laws of Louisiana, and which is domiciled in Louisiana and has a permanent physical location of business in Louisiana where records are held. R.S.56:8(16)(B)

Any person, corporation, or other legal entity which possesses a resident license from any other state or country shall not qualify for a resident license in Louisiana. R.S.56:8(16)(C)

Helpers, deckhands or any person assisting in commercial fishing while on board a crabbing vessel need not have a commercial fisherman's license provided the person in charge of the operation of a commercial fishing vessel, whether or not that person is the owner of the commercial fishing vessel, has a commercial fisherman's license and is on board the commercial fishing vessel. R.S.56:303.3

11.10 Reporting/Record Keeping

Wholesale/retail seafood dealers who purchase crabs from a licensed commercial fisherman shall record the sale on the three-part receipt form as provided for in R.S.56:303.7 and shall copy the name and license number on the receipt form and shall provide the commercial fisherman with one-part of the three-part receipt form. R.S.56:306.4(A)(2)

Wholesale/retail seafood dealers purchasing or acquiring crabs from commercial fisherman shall complete a commercial receipt form. The commercial receipt form shall be a three-part form signed by both the commercial fisherman and the wholesale/retail seafood dealer or his designee, attesting to that the information required to be provided by each is correct. One part of the receipt form shall be retained by the wholesale/retail seafood dealer, one part shall be given to the commercial fisherman at the time of the transaction, and one part shall be transmitted to the LDWF. R.S.56:306.5(B)(1)

Wholesale/retail seafood dealers are responsible for recording on the commercial receipt form that information provided by the commercial fisherman and is responsible for the following information at the time of purchase or transfer of possession of the catch from a commercial fisherman to a wholesale/retail seafood dealer: wholesale/retail seafood dealer's name and license number, commercial fisherman's name, license number and signature, transaction date, species identification, quantity and units of each species, size and condition of each species, unit price of each species, and permit number for species requiring a permit to harvest. R.S.56:306.5(B)(2)

Wholesale/retail seafood dealers shall, on or before the tenth of each month, make a return to the department of all commercial receipt forms representing actual transactions from every commercial fisherman during the preceding month. All commercial receipt forms submitted by a dealer shall be accompanied by a monthly submission sheet signed by the wholesale/retail seafood dealer certifying that the transactions submitted represent all of the transactions by that dealer from commercial fishermen for that particular month. R.S.56:306.6(A)

Dealer receipt form shall be a three-part numbered form provided by the department. The dealer receipt form shall be completed when crabs are purchased or received from commercial fishermen. The receipt form shall represent the actual transaction between the commercial fisherman and the dealer. The dealer shall fill out the receipt form in its entirety containing all of the information required in §201.D and E with the exception of the commercial fisherman's signature that shall be recorded by the fisherman. The "Dealer's Copy" of the receipt shall be maintained on file at the dealer's place of business or where the crabs are received. The dealer shall maintain the receipts for a period of three years. The "Department Copy" portion of the dealer receipt form shall be returned to the department by the dealer by the tenth of each month to include purchases made during the previous month. Along with the receipts for each month, the dealer shall submit a "Monthly Submission Sheet" provided by the department that certifies that the transactions submitted represent all of the transactions by that dealer from commercial fishermen for that particular month. The "Monthly Submission Sheet" shall fulfill the reporting requirements in R.S. 56:345. The dealer shall mail completed receipt forms to a predetermined address designated by the department. Dealers are responsible for obtaining dealer receipt forms from the department by calling a predetermined phone number. LAC 76.VII.201

Wholesale/retail seafood dealers, retail seafood dealers, restaurants, and retail grocers shall keep, in the English language: R.S.56:306.5(A)

- Records of the quantity and species of crabs acquired, the date the crabs were acquired, and the name and license number of the wholesale/retail seafood dealer or the out-of-state seller from whom the crabs was acquired. When creel limits apply to commercial species, records shall also indicate the number by head count of such species of crabs.
- Records of the quantity and species of crabs sold, the date the crabs were sold, and the name and license number of the person to whom the crabs were sold. When sold to the consumer, the records shall indicate the quantity, species, and date and shall state that the crabs were sold to the consumer.

Records required must be maintained for three years and shall be open to inspection by the department. R.S.56:306.5(C)

Any commercial fisherman possessing a fresh products license shall, on or before the tenth day of each month submit copies of their trip tickets and monthly submission sheets to the LDWF. R.S.56:303.7(C)

11.11 Shipping Records

Shipments containing crabs shall be plainly marked, the tags or certificates to show the date and names of the consignor and the consignee, with an itemized statement of the number of pounds of crabs and the names of each kind contained therein. R.S.56:307.7(A)

Bills of lading issued by a common carrier for such shipments shall state the number of packages which contain crabs, and the date and names of the consignor and consignee, with an itemized statement of the number of pounds of crabs and the names of each kind contained therein. R.S.56:307.7(A)